Instruments

HE MAGAZINE of MEASUREMENT and CONTROL

VOL. 23 SEPTEMBER 1950 No. 9

CLUDING THE *Journal of the Instrument Society of America*

D THE *Journal of the Southern California Meter Association*

Checking refrigerator compressor parts with Profilometer at Crosley Div., Avco Mfg. Corp., Richmond, Indiana. Most surfaces are held to a finish of 8 microinches or less.

UNIVERSITY OF MICHIGAN LIBRARIES

New! TAG "Humidicator"

reveals relative humidity

FAST! Just wet the wick... swing the instrument... read the thermometers—and a single setting of the scale shows percent relative humidity!

SIMPLE! This new TAG Pocket "Humidicator" requires no separate charts or tables . . . no technical knowledge to use!

STURDY! Integral mounting loops in the tough plastic case hold thermometers securely in place... help absorb shock!

ACCURATE! The TAG "Humidicator" utilizes the fundamental psychrometric ("wet and dry bulb") principle for determining relative humidity—and the twin wet and dry bulb thermometers are individually calibrated!

Yes, the new TAG Model 8704 "Humidicator" is a precise, pocket-size instrument carefully engineered to provide sturdiness, stability and service.

WESTON ELECTRICAL INSTRUMENT CORPORATION

Manufacturers of TAGliabue and Weston Instruments

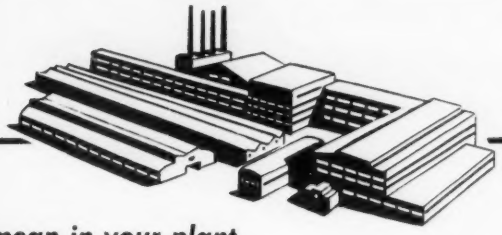
591 Frelinghuysen Avenue, Newark 5, N. J.

TAG

a controller that does so much...so well...

SERIES 500 *Air-Operated* CONTROLLER

in automatic control



Here's what these exclusive features mean in your plant

1 Calibrated control saves you hours of shut down time. Enables you to duplicate previously-established control actions exactly without cut-and-try... and to standardize controller adjustments for any process throughout an entire plant or national organization.

2 Zero reset and zero derivative time facilitate adjustments and start-up. Positive zero is useful during initial band and rate adjustments, testing and automatic start-up.

3 Mechanical interlock makes it impossible to accidentally go through "manual" to either "test" or "service." *Single gauge permits exact balancing of control and regulator pressures* before switchover—thus eliminating danger of "bumping" the process.

4 Almost anyone can service a Series 500 Controller. Even with replacement parts, a single adjustment puts the instrument back in exact calibration.

5 Absolutely true measurement. Control mechanism is operated by gold-plated "free vane" which imposes no retarding effect on measuring element. Made of beryllium copper, it is stronger, stays flat and in alignment, cannot be damaged in cleaning.

6 Reset stops. Ask the Bristol representative to explain this exclusive feature.

Bristol "500" Controllers are offered in five types—on-off, proportional, reset, derivative, reset plus derivative—to control temperature, flow, pressure, liquid level, humidity, pH.

Conversion from one type to another can be made by the user.

Investigate your new opportunity for accuracy and uniformity in automatic control. Send for new bulletins on "500" Air-Operated Controllers and other instruments in the new line of Series 500 instruments. THE BRISTOL COMPANY, 113 Bristol Road, Waterbury 20, Connecticut.

BRISTOL

Engineers process control for better products and profits

-from wiring to installation of instruments

FALSTROM

ASSEMBLY OF DESK CONTROL UNITS

-service on control panels is complete!

SEE OUR CATALOG IN SWEET'S

Now you can look to Falstrom for complete service on panelboards, switchboards, cubicles, instrument panels, entire control centers and switchgear housings. Falstrom does considerably more than design and produce functional and distinctive, finished housings. The new Falstrom service includes electrical wiring, piping, procurement and installation of instruments and other accessories as specified. All work performed at Falstrom is done by engineers and skilled technicians completely familiar with each phase of the installation. Check on this Falstrom service, now. Use the handy coupon below.

FALSTROM COMPANY

92 FALSTROM COURT • PASSAIC, NEW JERSEY

Gentlemen:

I am interested in the items checked. Please send complete information at once.

NAME

TITLE

COMPANY

STREET ADDRESS

CITY ZONE STATE

☐ INSTRUMENT PANELS
☐ CHEMICAL BOARDS
☐ GAGE BOARDS
☐ COMPLETE CONTROL CENTERS
☐ WIRING, PIPING AND INSTRUMENT INSTALLATION

Instruments

Vol. 23 SEPTEMBER 1950 No. 9

SPECIAL FEATURE

Report on Western Europe 906
(Last of three articles)
By Richard Rimbach

TECHNICAL ARTICLES

Users' Requirements for Control Valves 896
By W. H. Shellenberger

A New Method of Measuring Pressure Electrically 903
By Edward C. Blom

Combustion Air Control System for Single-cylinder Testing 904
By R. C. Fink and D. B. Colyer, Jr.

Calibration of Gas Flowmeters 908
By Albert E. Schuler

THE MONTH'S NEW INSTRUMENTS 916

OTHER REGULAR FEATURES

Editorial 895
Technical Societies 958
Manufacturers' New Literature 960
Advertisers' Index 964

JOURNAL of the
INSTRUMENT SOCIETY OF AMERICA

Secretary's Page 951
Treasurer's Report 952

JOURNAL of the
SOUTHERN CALIFORNIA METER ASSOCIATION

Sight Reading of Orifice Meters Charts 957
By Harry A. Faull

Instruments The Magazine of Measurement and Control is published monthly on the 15th at Pontiac, Illinois
Editorial, Subscription and Advertising Offices are at The Instruments Publishing Company, 921 Ridge Avenue, Pittsburgh 12, Pa

Richard Rimbach, *Publisher* — M. F. Behar, *Editor*
James F. Emge, *Assistant to the Editor* (new literature, etc.)

DISTRICT OFFICES AND MANAGERS

MEMBER ABC Audit Bureau of Circulation

James Condon, 36 Myrtle St., *Boston* 14, Mass. (Lafayette 3-0829). Richard J. Rimbach, Jr., Room 351, 551 Fifth Ave., *New York* 17, N. Y. (Murray Hill 2-0821). William J. Gallagher, Room 1102, Beury Bldg., 3701 N. Broad St., *Philadelphia* 40, Pa. (Baldwin 9-9940). Harold W. Haskett, 742 Elberon Ave., *Cincinnati* 5, Ohio (Grandview 4323); Room 615, 360 N. Michigan Ave., *Chicago* 1, Ill. (Andover 3-4299). Stephen E. Wright and James R. Wright, 411 North Tenth St., *St. Louis* 1, Mo. (Chestnut 1965). M. D. Pugh, 2721 N. Marengo Ave., *Altadena*, Calif. (Sycamore 7-2894). C. F. Goldcamp, 921 Ridge Ave., *Pittsburgh* 12, Pa. (Fairfax 1-0161).

SUBSCRIPTION RATES	*One Year*	*Two Years*	*Three Years*
United States, U. S. Possessions and Canada	$3.00	$5.00	$6.00
Latin America and Australia	4.00	6.00	8.00
All other countries except those noted below	5.00	8.00	10.00

For the present, subscriptions not accepted from Austria, Bulgaria, China, Czechoslovakia, Eastern Zone Germany, Hungary, Poland, Romania, Russia and Yugoslavia

Payments from outside the U. S. A. must be in the form of an International Money Order or check on a U. S. bank.

Position and company connection as well as products manufactured must be indicated in all subscription orders.
Copyright 1950 by The Instruments Publishing Company, Inc. Office of publication, 1600 North Main St., Pontiac, Illinois, Executive and Editorial Office, 921 Ridge Avenue, Pittsburgh 12, Pa.

Entered as second class matter, October 14, 1949, at the post office at Pontiac, Illinois, under the act of March 3, 1879.

UNIVERSITY OF MICHIGAN LIBRARIES

Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

Again it is up to Instrumentation to help increase war production by increasing the ratio of plant output per number of employees. It *was* done in 1940-1945; it can be done even better with *your* help; it *will* be done!—MFB

Protect American Instruments Against Tariff Cuts

By RICHARD RIMBACH, Publisher of *Instruments*

STARTING on September 28th, 1950 at Torquay, England, trade agreement negotiations are scheduled to be opened by the United States with Australia, Austria, Belgium, Brazil, Canada, France, the German Federal Republic, Guatemala, Korea, Luxemburg, New Zealand, Netherlands, Norway, Peru, Turkey, the Union of South Africa and the United Kingdom. The objective of the meeting, according to the State Department, is to encourage international trade by reducing tariff barriers between participating nations.

The future of the American instrument industry may depend on the government's tariff policy. The *proposed* tariff reductions are so sweeping in scope that they would have the effect of weakening or completely destroying U. S. production of instruments. Reductions would also weaken our National Defense.

There are some in our government who define "free trade" as the importation of merchandise without being subject to duty or other regulations. There are others who define free trade as a status which would permit foreign products to compete in our markets on an even basis with domestic production. In other words an adjustment of tariff rates which will equalize the cost of production of foreign products with that of comparable products manufactured in the United States by raising or lowering the rates to accomplish this result.

Certainly no one interested in our standard of living would want instruments, produced under much lower living standards, to be admitted under such low tariff rates as to permit them to be sold in this country at less than it cost to produce the competitive article in the United States. Certainly our wage rates and our living standards could not long be maintained under such a policy.

My position in regard to the tariff has not changed since I started to publish *Instruments* in 1928. This position is so well expressed in a statement recently issued by J. G. Shennan, President of the Elgin National Watch Company, that I will paraphrase the statement as made by him to express my ideas, as I feel that watches are instruments because they measure time:

1. *I oppose* any embargo on foreign-made instruments.

2. *I oppose* quotas which would create an artificial scarcity of instruments.

3. *I oppose* subsidies or other handouts, because I feel that the taxpayers should not have to support any industry.

4. *I do not* seek a stifling of competition, nor monopoly of the market, nor a competitive advantage for the American precision working industry.

5. *I do* believe an American manufacturer employing skilled Americans, in necessary and important work, should have sufficient tariff protection to equalize the advantage foreign producers now enjoy, due solely to their lower wage level. I ask only that this difference be equalized. This would not be a prohibitive tariff nor would it have the effect of creating an embargo on instruments.

6. *I do* believe a tariff is unfair and unjust if it is so low as to permit a low-wage foreign industry to flourish in the American market at the expense of an American industry vitally essential in time of war, and at the expense of the jobs and livelihoods of American workers.

7. *I feel* that the tariffs on the products of the precision working industry should be raised to equalize the difference between foreign wage levels and ours.

8. *I feel* that the tariffs on the products of the precision working industry should be raised to protect the national defense which should be of utmost concern to every citizen of the United States.

9. *I advocate* open covenants openly arrived at. I advocate that the deliberations at Torquay be made available to the American public without bias.

* * *

By reducing tariffs, we will increase imports, decreasing our own production and thus must increase taxes on a diminishing production. Therefore, if the Torquay meeting succeeds, in the sense in which Mr. Acheson regards a success, American industry and American labor must be prepared to make sacrifices in production and in employment.

I urge you to write your Senators and Congressmen, and lend your weight to our efforts.

USERS' REQUIREMENTS *for* CONTROL VALVES

By W. H. SHELLENBERGER, Standard Oil Development Co., Linden, N. J.

IN AN AUTOMATIC control system, there are three principal elements that contribute to the satisfactory operation of the system. These are (1) the primary element such as the orifice plate, thermocouple, Bourdon tube or float mechanism, etc.; (2) the instrument or output-regulating device containing such functions as on-off, proportional, reset or rate action and (3) the final control element which causes a change in the process in response to a change pick-up in the primary element. This final element for the purpose of this article is the diaphragm-motor control valve. All three elements must be properly applied and satisfactorily adjusted in order to accomplish the ultimate result necessary for product control. The diaphragm-motor control valve will be discussed herein from the standpoint of construction, flexibility, application and operation assuming that the first two elements have been properly applied and adjusted.

Valve Construction

Many types of diaphragm-motor control valves are produced today. Typical of these valves and the more commonly used is the type shown in Fig. 1. The two principal parts of the control valve are the valve motor and the body assembly. In many instances a third part is required, the valve positioner, which is normally mounted externally on the valve motor. Some of the many variations of valve motors are described here.

(1) *Diaphragm Motor*

The direct-acting diaphragm motor such as that shown in Fig. 1 consists of an air dome over a flexible diaphragm and diaphragm plate connected to a valve stem. Under the diaphragm is the bottom plate, spring and yoke. Air pressure applied on the top of the diaphragm causes the valve stem to move downward in opposition to the forces exerted by the valve spring plus any friction or valve unbalance. The reverse-acting motor is similar to the direct-acting motor in that the air pressure is applied to under side of the diaphragm to oppose the action of the spring in the opposite direction. The action of the valve is normally obtained for direct or reverse action only but not both. Valve motors are available which can be made reverse-acting from direct-acting or vice versa by changing the air connection and a few bolts and levers.

Other types of diaphragm motors are available such as the springless motor which has the advantage of increased power, but has no control as to position on air failure. The pneumatic piston has an advantage over the diaphragm motor in that a greater stroke may be obtained. Also, other types of valve actuators such as hydraulic pistons, solenoids, and electric motors may be used.

Diaphragm motors under normal conditions operate in the process industries with an air pressure range of 3-15 psig.

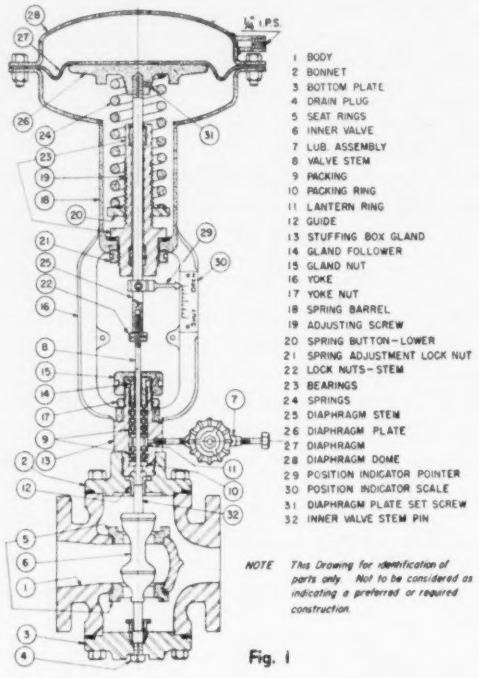


Fig. 1

for full stroke of the valve. This pressure range has been set as a tentative standard by the Scientific Apparatus Makers Association and is commonly furnished as standard from most suppliers. The diaphragm material should be as thin as practical, preferably in the neighborhood of ⅛ inch. As the thickness of the diaphragm material increases, the change in effective area of diaphragm tends to increase, which leads to non-linearity in the valve and eventually rejection by the user. A suggested method of limiting the diaphragm thickness is to provide material thin enough to have a minimum bursting pressure of 130 psig. across a two-inch circular opening. Material that meets this test will reduce the tendency of the diaphragm to rupture under the standard pressure range mentioned above. Molded diaphragms are furnished by most suppliers. These provide a minimum change in the effective area of the diaphragm as the valve moves through its stroke. Diaphragm motors are usually limited to travels of 4 in. Any motors with strokes beyond this become non-linear owing to the wide variation in effective diaphragm area and hysteresis in the valve spring that occurs over the stroke.

The valve spring is one of the more critical components of the valve motor. The spring should have a linear characteristic in order to obtain complete satisfaction from valve operation. It should be made of tempered alloy steel and should be fully enclosed in a metal housing for further protection from the atmosphere.

The yoke is the connecting member between the diaphragm head and the valve body and usually considered a part of the diaphragm motor. The yoke is provided by various suppliers in cast iron or steel construction. Caution should be exercised with steel con-

UNIVERSITY OF MICHIGAN LIBRARIES

struction so as to be sure that the steel is heavy enough to prevent any deformation from normal shocks experienced in shipment or handling. Steel will bend slightly without any visible notice of the deformation. This will cause unnecessary friction in valve operation and may be time-consuming in locating the trouble. Cast iron will break rather than deform and the yoke can then be replaced without any further inspection. The yoke should be connected to the valve bonnet so that the upper stem and valve stem are properly aligned. A suggested method of making this connection is with a locking nut or bolts. This construction will prevent turning or canting which as a result tends to provide a more positive alignment. Set screws are used in some cases to accomplish this function, but they do not provide the strength that is obtained by a locking nut or bolts. Two types of yokes are available, namely the open and closed type. The open type is preferred because it provides ready access to the stuffing box and spring adjustment.

(2) *Valve Body*

The valve body of the typical control valve shown in Fig. 1 consists of three principal parts: the outside housing, the inner valve and the stuffing box. The outside housings are made of castings of bronze, iron, steel or alloys and in smaller sizes are available as steel forgings. Standard valves may be obtained with screwed ends in line sizes up to and including 2 inch. Flanged valves are furnished in line sizes 2 in. to 16 in. Valve bodies for diaphragm-motor valves are usually of special construction in sizes over 16 in. One of the most recent accomplishments relative to valve bodies in which the ISA has been instrumental, is the standardization of the face-to-face dimension of flanged control valve bodies among the various suppliers for valves up to and including the 8-in. size.

In the valve body there are several parts whose construction should meet certain specific requirements.

(a) The top and bottom plates should be interchangeable with the reversal of the valve body. Also, they should be provided with a pilot flange so as to provide concentricity for the guide and stem by piloting into the valve body. In order to assure proper alignment the pilot section should have a diametrical clearance not to exceed 0.005 in.

(b) The guides should be of different material from the stem so as to prevent "galling" of the stem. Like materials tend to cause galling with the result of increased binding in the stem. Most suppliers provide a differential of at least 125 Brinell numbers between the guide and stem materials. For example, on standard applications the stem may be Type 304 stainless steel whereas the guides are Type 440 stainless steel. Type 304 S.S. has a hardness of around 180 Brinell compared to 450 to 500 for Type 440 S. S. The top and bottom guides should be concentric with the seat rings to assure proper alignment of the inner valve with the seat rings.

(c) The stuffing box or gland seal is usually the member of the valve body that gives the maximum friction in the valve movement. It should be deep enough to prevent leakage with the minimum amount of compression on the packing. It is suggested that the depth of the gland be long enough to provide for two standard rings of packing below the lantern ring and four rings of packing above the ring. The lantern ring should be of solid construction so as to prevent canting such as sometimes occurs with split ring construction. The gland nut and follower should be constructed in such a manner that three to four threads of the gland are taken up before compression of the packing begins. This construction is desirable owing to the possible corrosion of the threads which may occur below the thread engagement after a considerable period in operation, particularly in corrosive atmospheres. However, this problem is not so serious with the bolted gland construction as the bolts may be more readily replaced in the event of severe corrosion of the threads. It should be noted that a metal ring should be provided at the bottom of the gland to minimize leakage of packing to the valve body. The clearance tolerance between this ring and the stem should be a maximum of 0.015 inches.

Valves subjected to high temperatures or below-freezing temperatures should be provided with radiating fins to cool or raise the temperature of the stuffing box as the case may be, so that standard packing and grease may be used. The temperatures at which radiating fins may be used may vary considerably with users. The suggested limits at which they should be installed are above 450 F. and below 0 F. Without the radiating fins, the grease or packing may become hard and cause unnecessary friction in the stuffing box.

(d) The inner valve (or valve plug as it is sometimes referred to) may be one of many types of design or characteristics. The shape or contour of the inner valve determines the flow characteristic that may be obtained from the control valve. Space does not permit a full discussion of all types of inner valves that can be furnished. Accordingly, the discussion will be confined to four of the most commonly furnished inner valves as used in valves actuated with proportional controllers. These are shown in Fig. 2 and they should be suitable for use with direct or reverse acting motors. Sections B and D of double-seated valves should be so formed that they do not cause a restriction of the effective port areas as the inner valve approaches full lift. This is essential in order that the valve will meet the flow characteristics required for the type of inner valve specified. The amount of material above the seating surface of the inner valve shall be at least ⅛ in. and should be increased 1/16 in. for each 1 in. diameter of inner valve to allow enough material for machining the seat from time to time as required. (Section E, Fig. 2)

The characterized V-port or parabolic inner valve should have port openings shaped in such a manner that the valve will produce equal percentage increases in flow for equal amounts of valve lift with constant differential pressure across the valve body. This equal-percentage characteristic is based on a leakage flow (inner valve just off seat) of 2 percent of the maximum valve capacity (Curve A, Fig. 2). For a perfect line on a valve having a 12-psi. pressure range for full travel, 1 psi. increase in air pressure on the diaphragm will produce 38 percent increase in flow rate. For practical reasons a tolerance is given so that the actual increase in flow rate shall be within 33 and 43 percent.

The straight parabolic or linear inner valve should be shaped to conform to the flow characteristic of curve B, Fig. 2. For valves which have a 12-psi. change from closed to open or vice versa, a flow change of 8⅓ percent of valve capacity for a 1-psi. change will result in a perfect curve. This change may vary from 6 to 10 percent depending on the workmanship of manufacture.

Single-seated inner valves should be absolutely tight shut off and should be cut to give the same characteristic as the characterized double seated plugs (curve A Fig. 2).

(3) *Valve Positioners*

Valve positioners are required on many control valves to overcome friction and to give stability to the valve.

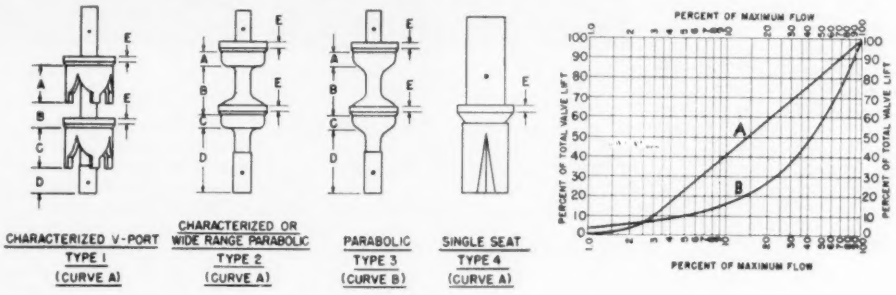


Fig. 2

The requirements for their use may vary widely among the users. However, the following is suggested as a guide for the services or conditions on which their use is essential.

1. All valves actuated by floating action temperature controllers.
2. Valves actuated by level controllers where stability of flow is required.
3. Valves larger than 4 inches in size.
4. Valves requiring extra force by reason of process conditions or valve type.

The valve positioner is a subject in itself and no attempt will be made here to discuss its requirements or characteristics. However, it should be considered from the standpoint of operability, adjustment and flexibility. The positioner should be sensitive to the slightest stem movement. It should be fast in response to change in valve position and at the same time should be relatively stable so as to avoid hunting or cycling. It should be flexible enough to be adjustable for use on valves of various strokes and should be arranged so that it may be removed from the valve without having to disconnect the air line to the valve motor.

(4) *General Requirements*

Some general requirements applicable to most mechanical equipment should also cover control valves. For example, all castings should be true to form, free from shrinkage, strains, scale, lumps, blisters, sandholes and other defects. The body castings should be provided with fillets on corners where the concentration of stress may be expected.

Threaded holes for seat rings should be machined so as to be concentric with the outside of the bonnet and bottom plate raised faces. Spot and back facings on flanges should meet ASA requirements. Welding defects should not be permitted unless a satisfactory agreement has been reached with the user.

Valve Tests

After the control valve has been assembled and carefully checked for proper parts, defects, alignment, etc., several tests are required in order to assure the user that a satisfactory valve is being furnished. The tests recommended to be performed on each control valve are four in number:

(1) *Hydrostatic Body Test*

Valves such as gate, globe, etc. as well as diaphragm motor control valves are normally furnished to some design or working pressure, commonly 150, 300, 400 psi. etc., or standard ASA ratings. These valves are usually tested at test pressures, sometimes several times their working pressure. This test is made on the valve body only after all machining has been completed. Although the test pressure for globe and gate valves is usually around three times the working pressure for forged, cast carbon steel and low alloy steel bodies, control valves may be tested at lower pressures because they are not normally subjected to the same high pressure drops and fatigue as globe and gate valves. It is therefore satisfactory to test control valves in the neighborhood of 2½ times the primary service pressure rating. For gray iron, brass or bronze bodies, the test pressure may be only twice the primary service pressure rating.

(2) *Seat Leakage Test*

It is estimated that approximately 80 to 90 percent of the control valves used in the oil refining industry are in throttling services. The necessity of the seat leakage test for tight shut-off of control valves may then be somewhat questionable. In the event of emergencies, air failure or other mechanical troubles, the control valve may be expected to close. Accordingly, it is essential that the valve be absolutely tight or that its leakage be minimized. Tightness in single seated-valves may be accomplished more readily than in double-seated valves.

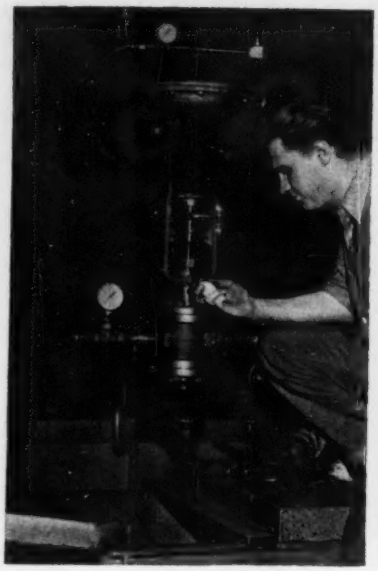


Fig. 3

Fig. 4

Single-seat valves are tested for tight shut-off rather than seat leakage. The test can be made by blanking off the outlet with a flange or plug and installing a pressure gage or mercury column in the blanked-off flange (see Fig. 3). An upstream air pressure of 60 psig. is then maintained for the test. With this pressure on the upstream side of the valve, an allowance of not more than 1 psig. build-up in three minutes will be permitted on the downstream side of the valve. Any valve exceeding this pressure should be rejected.

The double-seated valve is difficult to obtain with tight shut-off. The differential expansion between the body material and the inner valve with the double-seated construction, together with changes in temperature of the line medium, cause leakage through the valve ports to be inevitable. It is therefore recommended that the plug and seat rings be ground in at ambient temperature. This provides a standard condition of seat leakage for all valves regardless of operating conditions.

Most suppliers can guarantee a maximum leakage equal to 0.5 percent of the flow which the valve will pass when fully open. There are several methods of testing for seat leakage. A recommended method is similar to that described above for single-seated valves. (See Fig. 4). A pressure of 60 psig. is maintained in the upstream side of the valve with water as the medium for the duration of the test. The amount of water collected at the valve outlet is weighed for a specified time of leakage. The percent of leakage is obtained from the following calculation.

Percent leakage $= (L/Q) \times 100$

where L = leakage (cf.)

Q = Cap. of valve wide open. cf.

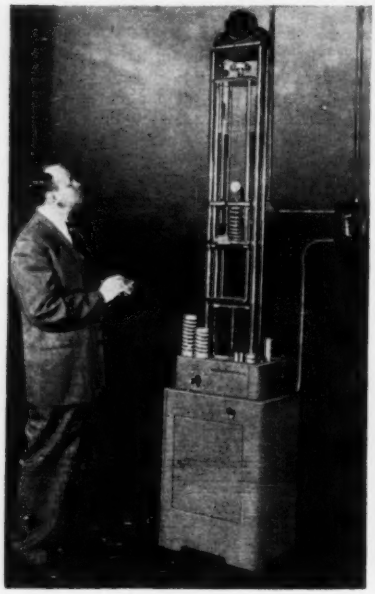
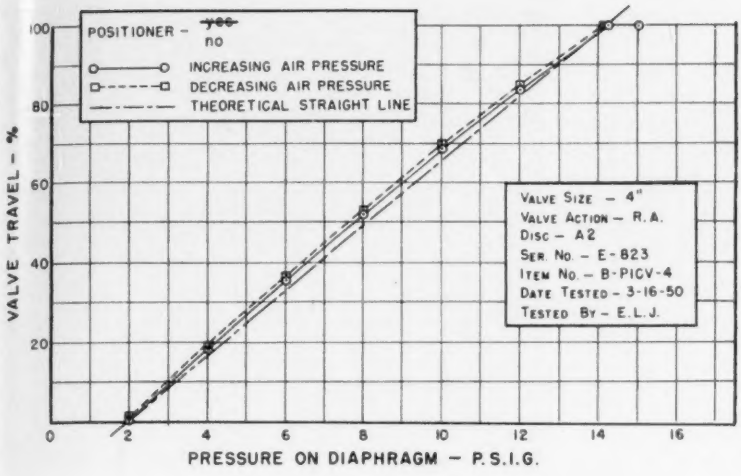


Fig. 5

Fig. 6

UNIVERSITY OF MICHIGAN LIBRARIES



VALVE CHARACTERISTIC TEST

Fig. 7

(3) *Valve Construction Characteristic Test*

As a rule the valve spring is first checked for "K" value before being assembled. Fig. 5 shows the apparatus used by one manufacturer to check the linearity of the spring before assembly. The spring is first loaded with 3 psig. air pressure using a diaphragm top of the size with which the spring may be used. This loading sets the zero point of valve travel for the spring. The valve is then put through its full stroke by increasing air pressure. If the air pressure reading at full stroke does not meet the 15 psig. required at full stroke within 1 percent, the spring is discarded. Any spring that does not meet this requirement will most likely cause the valve to be rejected in the test which follows.

In order to assure the user that a control valve will meet the linearity, range and "dead spot" limitations he requires, a valve construction characteristic is recommended. This test is recommended to insure the following:

(a) A straight line relationship between valve stem travel and diaphragm motor air pressure.

(b) Proper spring characteristics.

(c) Valve motor, stem, inner valve and body alignment.

(d) Smooth, first-class machining.

The apparatus used in performing this test may vary considerably. The simplest method involves a motion indicator of the dial type reading to the nearest 0.001 inch to measure the stem movement (see Fig. 6). For measurement of the diaphragm motor air pressure a mercury column with a range of 0-36 in. is satisfactory.

All tests shall be run on completely assembled valve units. The stuffing box shall be fully packed and made up hand-tight. During the test the stem shall be lubricated with a light oil instead of the regular grease lubricant. The standard range of air pressure commonly used for full stroke of control valves is 12 psi. This range, as previously mentioned, has been generally standardized from 3 to 15 psig. in the process industries. The air pressure for the valve characteristic test shall be supplied to the diaphragm motor successively at 3, 6, 9, 12 and 15 psig. pressure points (0, 25, 50, 75 and 100 percent valve-stem travel points, respectively). An additional pressure point of 16 psig. should be applied to check over travel of the valve stem. Pressure points shall then be recorded in the reverse order, including the zero psig. point to check valve stem under-travel. Care should be taken to prevent overshooting the desired pressure. At each pressure point the dial indicator shall be read and the reading recorded. These points shall then be plotted on a graph with diaphragm-motor pressure vs. valve-stem travel (see Fig. 7). The distance between the up and down curves shall at no time be greater than 2 percent of the total valve stem travel. For valves having a stem travel of more than 1½ inch, this deviation may be increased to 5 percent. When a valve is equipped with a valve positioner this limitation is reduced to 0.5 percent.

While this method is probably more accurate than any other, it is time-consuming, hence undesirable from the standpoint of mass production. As a result, some manufacturers provide apparatus which operates automatically after the valve is set up with the motion recorder and diaphragm motor air pressure recorder. (See Fig. 8.) A single two-pen recorder will satisfactorily furnish data similar to those obtained with a dial indicator and mercury manometer. A pneumatic motion transmitter is required to actuate the recorder pen for valve travel. Air pressure to the diaphragm motor is measured directly on the second pen. The final result is a record of the two recording pens which theoretically should coincide at the designated check points (see Fig. 9). The tolerances of these curves shall be the same as that indicated for both up and down curves previously mentioned for plotting on the graph. Fig. 10 shows the resulting curves after valve positioner has been added.

(4) *Diaphragm Chamber Test*

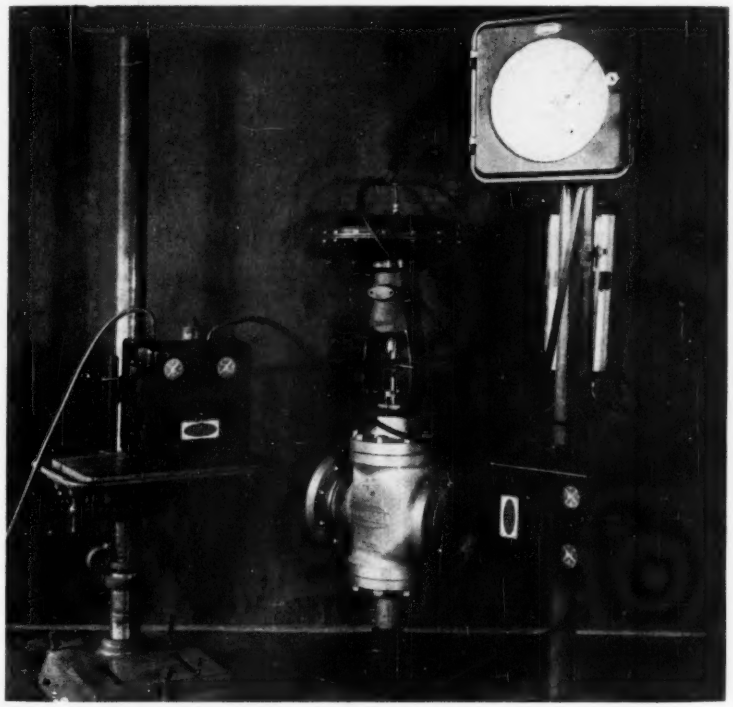


Fig. 8

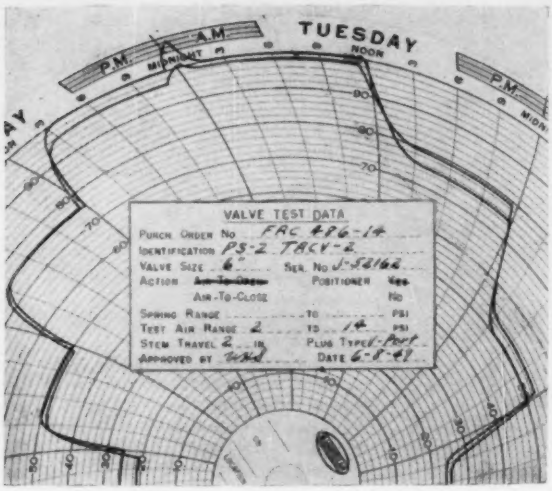


Fig. 9

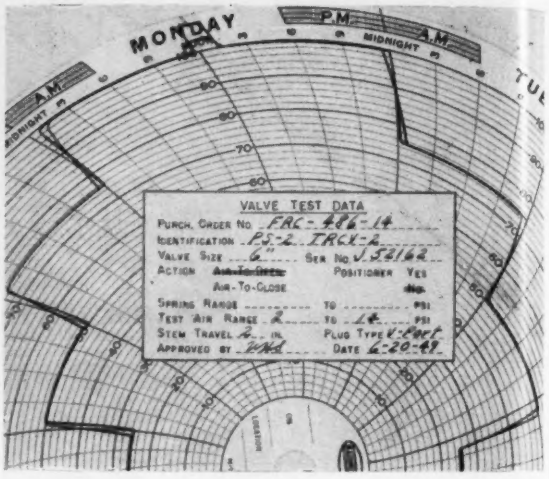


Fig. 10

Diaphragm motors are available in varying sizes dependent on the valve size and pressure drop the valve is designed for. These sizes usually vary in area from approximately 40 sq. in. to 250 sq. in. Instrument air supplied to instruments and valve positioners is usually available at 50 psig. and in some instances 100 psig. Although most control valves operate at a maximum pressure of 15 to 17 psig., it is possible to obtain full line pressures on the valve diaphragms. Instances of this have occurred in the past where cast iron chambers have fractured, causing hospitalization to personnel. Consequently it has been deemed necessary to provide a diaphragm chamber test to determine the safe working pressure of the chamber. It is therefore recommended that the chamber be tested with air at least 50 psig. after the valve has been completely assembled. The 50-psig. limitation is set to take care of the largest chamber. The smaller chambers are capable of withstanding considerably higher pressures.

Valve Size

In selecting a control valve for a particular process application, the normal procedure, after first selecting the type of inner valve desired, is to pick the size for the operating conditions from the manufacturer's slide rule or nomograph. As a rule, the user has his own pet rules for selecting the valve required depending on the various conditions under which he plans to operate. A suggested guide that may be used is to size the valve so that not more than 80 percent of the area is open when maximum flows anticipated are passed. Under normal operation it is desirable that the valve have between 40 and 60 percent of the area open. This provides the maximum flexibility to changes in flow rate in either direction. It should be emphasized that all valves may not be applicable to this guide and experience only can dictate the deviation necessary to select a suitable valve.

For Liquids $C_v = Q_L \sqrt{\frac{G_L}{\text{Delta P}}}$

For Steam $C_v = \frac{Q_s}{63.5} \sqrt{\frac{V}{\text{Delta P}}}$

For Gases $C_v = \frac{Q_g}{1360} \sqrt{\frac{G_g (460 + F}{\text{Delta P Pa}}}$

Q_L = the quantity of liquid in gallons per minute.

Q_s = the quantity of steam in lbs. per hour.

Q_g = quantity of gas in standard cu. ft. per hour at 60°F. and 1 atmosphere.

G_L = Sp. Gr. of liquid, referred to water at 60°F.

G_g = Sp. Gr. of gas, referred to air at the same conditions of temperature and pressure.

Delta P = design pressure drop in lbs. per sq. in. This cannot exceed 50% of Pa for gases and steam.

Pa = absolute pressure in lbs. per sq. in. directly upstream of valve.

V = specific volume of steam at the given steam conditions in cubic feet per pound.

F = temperature of flowing fluid in Deg. Fahrenheit.

Fig. 10A

The flow coefficient C_v of a valve is normally assumed constant for any given size valve and manufacturer. It may be defined as the quantity of water in gallons per minute that will pass through a fully-opened valve under a pressure differential of 1 lb. per sq. in.

The control-valve slide rules and nomographs available for the various manufacturers vary widely as to valve capacity. In the process industries, valves are normally sized for the C_v at maximum valve lift. This coefficient depends on several factors: nominal entrance area, area coefficient, ideal flow coefficient, loss coefficient. No attempt is made here to describe the effect of the various factors on the valve coefficient but reference is made to Eckman and Werey in their article on "Control Valve Body Design" for a full explanation. (*Instruments*, March 1949, pages 269-273.)

To determine the flow through the valve at other conditions than those de-

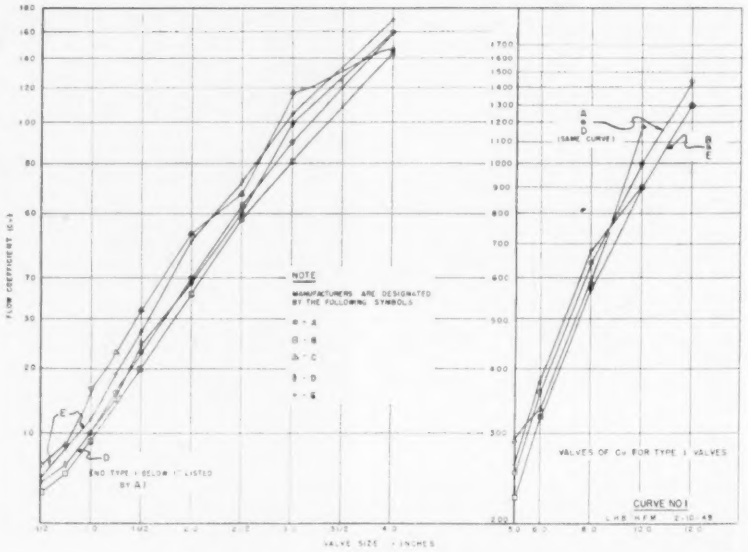


Fig. 11

UNIVERSITY OF MICHIGAN LIBRARIES

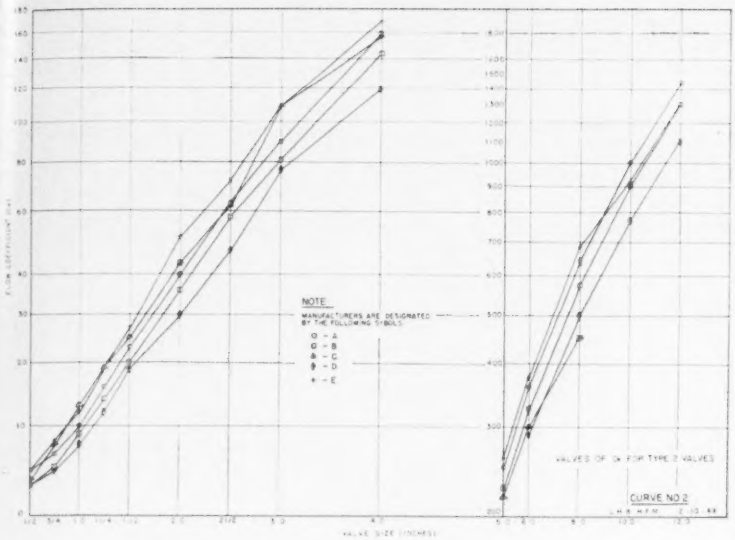


Fig. 12

fined above, it is merely necessary to use certain established relationships which are dependent upon the fluid flowing through the valve, the state of the fluid and the differential pressure across the valve. These relationships are defined in terms of flow coefficient C_V as shown in Fig. 10A.

In effect then, as may be seen above, the flow coefficient C_V is a direct indication of the valve capacity at the given conditions.

The attached curves (Figs. 11, 12, 13, 14) have been plotted with capacity, as represented by flow coefficient C_V, on the ordinate scale vs. valve size on the abscissa scale.

Referring to Figs. 11 through 14, it is worthwhile to note that the variation in flow in some instances is as high as 100 percent between the stated values of various manufacturers.

Tabulated in Fig. 15 is a survey which clearly shows the trend which manufacturers have taken over a period of years in attempting to set capacity limits of their valves. In analyzing the results of this table, there appeared to be several obvious reasons for the manufacturers' trend in revising their valve capacity figures upward, where no change in design has been accomplished. These might be described briefly as follows:

1. Manufacturers, when originally sizing control valves, wanted to assure themselves that the valve was not oversized and, as a consequence, were extremely conservative in setting their capacity limits so that the valve would be within the good control range, and they therefore added a factor of less than 1 in preparing their sizing charts and nomographs. As more information was obtained and consumers and users become more familiar with control valves, this figure was increased.

2. Further, a good deal of manufacturers' capacity figures are based on empirical relations with little experimental or other supporting data. While this is still true in the larger sizes, it is believed that, in the smaller size, actual test runs and field trials have contributed materially to the capacity information which the manufacturer now has.

Figs. 10, 11 and 13 suggest that where a straight line exists when plotted on a semi-log scale, capacities have been extrapolated by the manufacturers. In this manner, the capacity of one size valve, say a 1-in. size, could be determined experimentally and for other sizes could be estimated from the relationship:

C_V (any size) $= C_V$ (1 in. size) $\times D^2$, where D^2 = square of nominal valve size.

For curves which vary appreciably from a straight line, it would appear that this data was obtained experimentally by the manufacturer, and would tend to reflect truer capacity figures.

To bear out the above assumptions, some test data are available to show the deviation of C_V for various sized valves from that indicated in manufacturer's slide rules and nomographs.

Fig. 16 lists the field data and calculated C_V for twenty-four valves. The readings were all taken with the valves in actual service. No checks of valve stroke or accuracy of position indicator were made. Using the formula a valve coefficient of the partially open valves was calculated. The "wide-open" coefficient was then determined from the partly-open coefficient and the manufacturer's data on valve capacity at various openings for the particular type of valve. These valve coefficients are necessarily only approximations. Slight errors in valve-position reading, or incorrect valve adjustment, would cause large errors in the wide-open coefficient as calculated. Also, uncertainties of exact valve characteristics

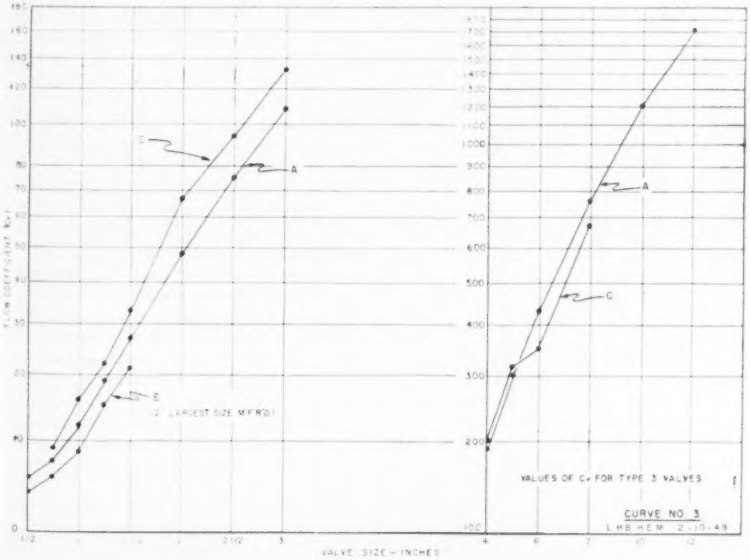


Fig. 13

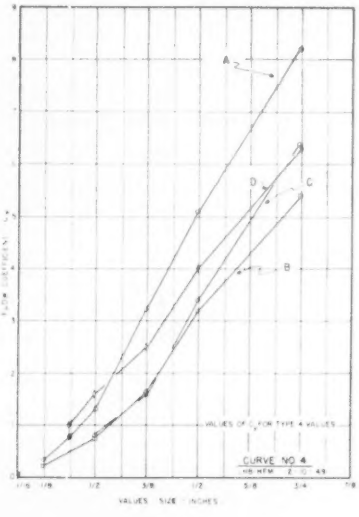


Fig. 14

and wear of the plug or seats would preclude any real accuracy.

The valve coefficients as determined for 2-inch valves agree reasonably well with the claimed capacities. Almost certainly the values obtained for valves C, F, G and H are in error; probably because of errors in valve position. The calculated C_Vs average 35.9 against the average of the claimed figures of 42.9. It should be noted that valve A was full open and its C_V of 33.7 is presumedly accurate.

The valve coefficients for 2½, 3, 5 and 6-inch valves are consistantly under those of the manufacturers. C_Vs for the 2½-inch and 3-inch valves average about 65 percent and for the 5-inch and 6-inch valves only 50 percent of the averages of the manufacturer's stated C_V. Valves A and C in the 5 inch size were wide open and the C_Vs as calculated should be accurate.

The methods used in obtaining data were not accurate enough to yield conclusive results. The data wanted were from valves in service and in average conditions, not in new condition or after a shop overhaul. Such valves must be checked full open for accurate results. As it is usually impossible to obtain full open figures with the valve in actual service, a test setup would be required.

MANUFACTURER'S TRENDS IN SETTING FLOW COEFFICIENTS (CV)

Nominal Size Inches	A Type 1 1934*	A Type 1 1947*	A Type 1 Present	B Type 1 1947*	B Type 1 Present
3/4	3.44	4.2	8.1	-	-
1	7.48	9	12.1	9	10
1-1/4		-	19	-	16
1-1/2	16.4	20	27	20	20
2	29.5	36	51	36	40
2-1/2		-	72	58	63
3	69.5	85	105	82	90
4	117	143	170	148	160
5			260	-	250
6	256	313	380	300	360
8	467	570	680	560	640
10	740	900	910	900	1000
12	1060	1300	1300	1300	1440

* The Dates Shown are Approximate only.

Fig. 15

Valve	Delta P	GPM	SG	% Open	Type	Cv	Mfg. Cv
			2 INCH VALVES				
A	22	204	0.601	100	VPORT	33.7	35.7
B	67	102	0.835	54	VPORT	32.6	35.7
C	37	127	0.601	90	VPORT	23.2	35.7
D	58	175	0.835	78	PARA	46.7	45.5
F	55	110	0.60	62.5	VPORT	24.6	35.7
G	152	332	0.65	50	VPORT	66.1	35.7
H	40	71	0.62	75	VPORT	23.4	35.7
			2-1/2 INCH VALVES				
A	150	318	0.663	60	VPORT	44.2	61.1
B	190	59.1	0.628	25	PARA	38.0	69.3
C	175	133	0.628	35	PARA	47.0	69.3
D	72.5	296	0.747	66	VPORT	54.6	55
E	47	212	0.601	71	VPORT	38.7	55
			3 INCH VALVES				
A	42	86	0.630	25	PARA	66	91.5
B	32	347	0.714	70	VPORT	86	79.7
C	85	156	0.774	50	VPORT	74	80
D	124	115	0.756	70	VPORT	27	80
			5 INCH VALVES				
A	55	897	0.932	100	VPORT	116.5	243
B	55	961	0.940	87	VPORT	136	243
C	65	1110	0.932	100	VPORT	132	243
D	80	770	0.932	80	VPORT	96	243
			6 INCH VALVES				
A	54	697	0.884	50	VPORT	268	355
B	73	642	0.800	50	VPORT	202	317
C	72	643	0.920	69	VPORT	121	355
D	128	327	0.632	40	VPORT	115	355

Fig. 16

Installation

The installation of the control valve is the final requirement to insure that the operation of the valve will be satisfactory for the operating conditions. In most process industries a by-pass is installed around the control valve to permit the process to continue to operate in the event of valve failure or to permit maintenance to be performed on the valve. This by-pass is an expensive installation, particularly in the larger size valves. The trend today is to do away with the by-pass for economy reasons and substitute a side-operated handwheel on the control valve for manual operation. The problem to be encountered is to build the handwheel of such design that it is economical as well as practical. The handwheels available today are expensive or, if not expensive, they are unsatisfactory.

The location of the control valve in the pipe line is varied by many likes and dislikes by the users. Fig. 17 shows a suggested method of installing the control valve in the pipe line. The block valves on either side of the control valve should be gate valves. The by-pass valve should be a globe valve up to and including the 4-in. size above which a gate valve may be used. The by-pass valve should also be at least one size larger than the control valve. A manifold bleeder valve should be installed on the upstream side of the control valve to relieve line pressure when maintenance has to be performed on the valve. Some users prefer to have an additional bleeder valve downstream of the control valve for this purpose.

The most desirable position for installation of the control valve is in a horizontal line with the valve vertical. Other positions, such as installation in a vertical line with the valve horizontal, are satisfactory but this type of installation causes unnecessary strain on the valve superstructure and tends to cause wear on one side of the moving parts.

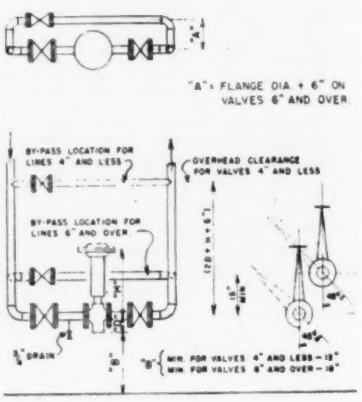

"A" = FLANGE DIA + 6" ON VALVES 6" AND OVER
BY-PASS LOCATION FOR LINES 4" AND LESS
OVERHEAD CLEARANCE FOR VALVES 4" AND LESS
BY-PASS LOCATION FOR LINES 6" AND OVER
"B" MIN FOR VALVES 4" AND LESS - 15"
MIN FOR VALVES 6" AND OVER - 18"

Fig. 17

Control valves should always be accessible from the ground or a platform for maintenance work. It is desirable but not essential to locate the valve in the vicinity of a transmitter or control instrument for calibration purposes.

Conclusion

This article has attempted to point out some of the major operating problems in control valves which concern maintenance personnel in their every day use. It is hoped that the discussion of the various components and tests of the control valve will indicate the necessity of good design required in valve construction. The need of test data for determining valve capacity such as that covered in the discussion of the valve C_V indicates the necessity of obtaining more concrete information for valve sizing. Finally, the control valve is not just another valve, but a critical link in the chain of control elements on which the success or failure of the automatic control system is dependent.

UNIVERSITY OF MICHIGAN LIBRARIES

A New Method *of* Measuring Pressure Electrically

By EDWARD C. BLOM, Electrical Engineer, The Hays Corp., Michigan City, Indiana.

IN THE early stages of the Hays magnetic oxygen analyzer development program, it became evident that some means for correcting the error introduced by changes in absolute gas pressure of the sample would be necessary. Such a device must be rugged and reliable under extremely difficult operating conditions such as those encountered in industrial power plants. The method described below meets the challenge in an unusual manner.

Fundamentally, the operation is simple. A sealed chamber containing a gas of a known pressure is heated until the pressure within the chamber exceeds the sample pressure applied to the opposite side of the measuring diaphragm, at which time a pair of electrical contacts separate, turning off the heater. When the chamber cools the contacts reclose to apply more heat. After a short time, the chamber temperature will stabilize at a value which is proportional to the pressure being measured. The temperature of the chamber is then measured by a resistance thermometer. The result is a measure of the sample gas pressure in terms of electrical resistance. Once in terms of electrical resistance, the device may operate a recorder, a remote indicator, a controller, or it may correct for errors introduced into another measuring instrument whose accuracy is affected by pressure variations.

There are, of course, many methods of measuring pressure in terms of resistance. The method described herein possesses several advantages not found in the more common methods. First, there are no delicate mechanical linkages to stick when exposed to dirty atmospheres. Second, all parts exposed to corrosive gases can be protected by plating; the corrosive gases cannot touch the sensitive components. Third, all mechanically delicate components are permanently sealed inside the measuring chamber where they cannot be harmed. The remaining components can be repaired or replaced easily and rapidly without resorting to special techniques. Fourth, the mechanism will not be harmed if it is accidentally dropped. Lastly, all components are completely interchangeable. These last two features are especially important to the man who must repair the instrument in the field.

The kind of gas to be used in the chamber also presents somewhat of a problem. Several gases were tried. However, the only one which performed satisfactorily was argon. Over long periods of time, at the elevated operating temperatures, the other gases of greater chemical activity reacted with the metals of the chamber and soon changed the calibration of the unit.

Fig. 1

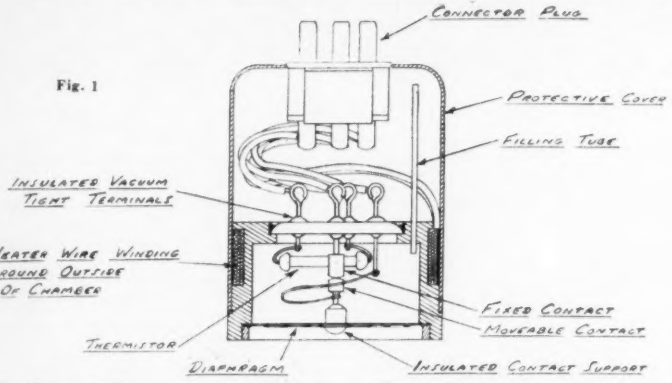


Fig. 1 shows a cutaway view of the measuring unit with its diaphragm, the electrical contacts and the temperature-measuring element, all sealed within the chamber. A thermistor is used as the temperature-measuring element because of its high rate of change of resistance with changes in temperature. A high-resistance alloy wire wrapped around the outside of the chamber serves as the heating element.

The sensitivity of the device to ambient temperature variations is quite low. In a test over the temperature range of 90 to 150 F., the resistance change was less than 1 percent. However, the instrument is sensitive to direct air currents. It should, therefore, be placed in a housing that will protect it from drafts. The response time of the instrument varies from one minute to ten minutes, depending upon the magnitude of the change. The slow rate of response provides a desirable averaging action where mild pressure oscillations are present. It is not intended for surge recording. The reading accuracy of the instrument in its present state of development is 1 mm. at 740 mm. Hg. For many applications, however, this degree of precision is adequate. Fig. 2 shows a typical pressure vs. resistance response curve. To operate at pressure ranges other than the one shown, it is only necessary to change the setting pressure of the gas within the sealed chamber. The nonlinearity of the response curve can be reduced considerably by connecting the thermistor as one arm of a Wheatstone bridge circuit where a slide wire serves to determine ration of two of the arms. The position of the slidewire arm will then be a very nearly linear function of the pressure being measured.

The remainder of the instrument is a thyratron-controlled relay circuit, Fig. 3. If the control contacts within the chamber are connected directly in series with the heater, the resistance of the thermistor will change erratically as a result of the heat developed at the contacts. Contact pitting may also occur. By minimizing the current passing through the contacts, these troubles may be eliminated. The circuit operates as follows. The thyratron control tube serves as a relay. When its control grid is connected to ground, as is the case when the control contacts are closed, the tube will conduct and pass current through the heater coil. When the contacts are open, the phase-shift network consisting of resistor R and capacitor C, will shift the phase of the grid supply voltage so that the grid will be negative when the plate voltage is positive. The tube, under this condition, will not conduct and no current will pass through the heater.

The only maintenance required by the instrument in more than two years of continuous service is a periodic replacement of the thyratron tube about every six months. The device is rugged and foolproof—it should find many industrial applications.

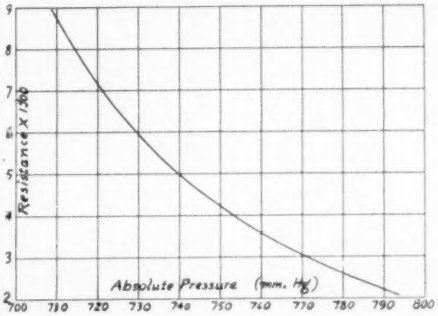


Fig. 2

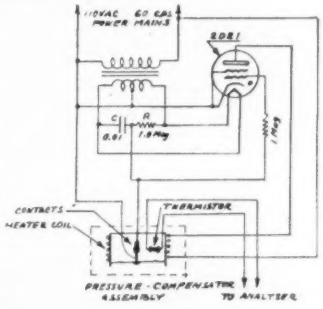


Fig. 3

Combustion Air Control System *for* Single-cylinder Testing

By R. C. FINK and D. B. COLYER JR., Purdue University, Lafayette, Indiana

IN most types of engineering work, the designed or revised product, or even an idea, must be proved; it must be tested to see that desired specifications are met. It is a well-known fact that the effect of one variable on operational testing cannot be evaluated unless other variables affecting this operation are held constant.

The control of engine variables in engine testing never ceases to be a major problem. Test data can be of doubtful value if certain variables are not held constant during engine operation. The test engine located at Purdue has excellent control features for engine variables.

The 17.6 cu. in. displacement single-cylinder test engine, located in the engines laboratory of the Aeronautical Engineering School at Purdue University, has control features for fuel flow, coolant temperature, lubrication, and combustion air pressure, temperature, and humidity. Speed is regulated through an electronically controlled a-c. dynamometer.

The engine is provided with two parallel fuel systems for alternate operation. Each unit has a supply tank which allows fuel to flow through a flowmeter to a leveling tank and to the engine injection pump.

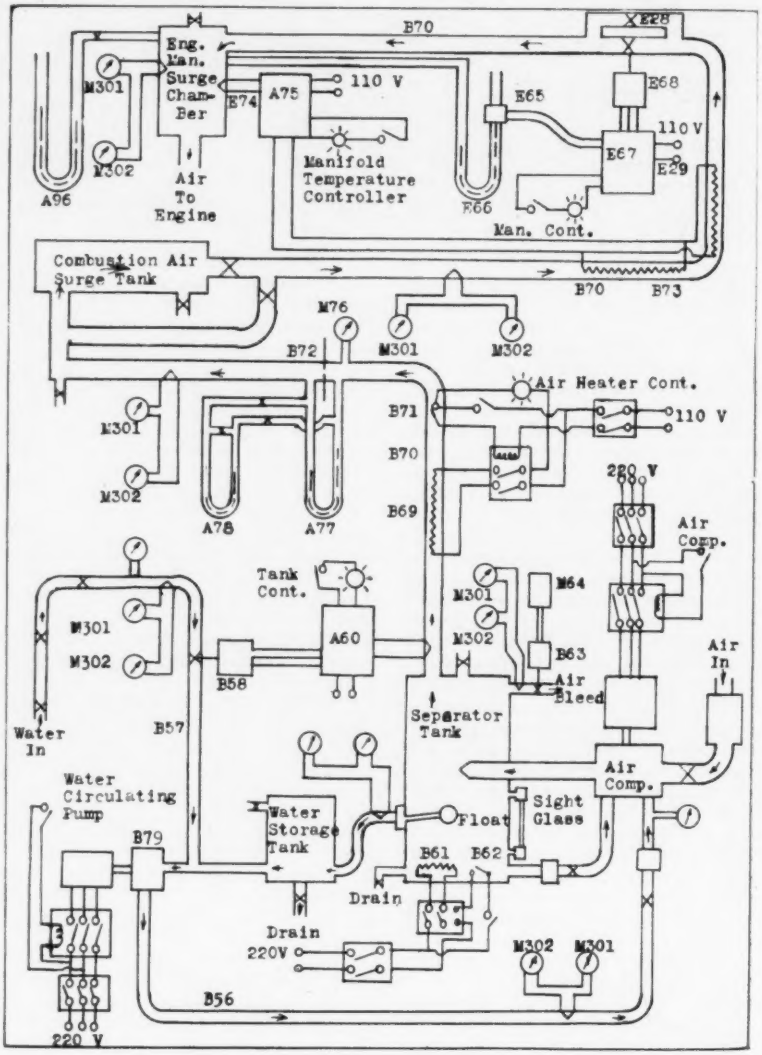
The coolant system used on this engine is an automatically controlled one. Coolant is pumped from the bottom of a cooling tower to the engine jacket where it is returned to the tower through a coolant-temperature-controlled motor valve. An electric heater is provided to aid in bringing the coolant to temperature. Coolant temperature can be maintained closely with the use of this system. High coolant temperatures may be attained by placing the coolant under sufficient pressure to prevent boiling.

An electronically controlled a-c. dynamometer maintains engine speed constant at a desired setting. A control device provides means for motoring, absorbing, or a combination of both to maintain constant speed. Speed is varied by a control on the main control panel.

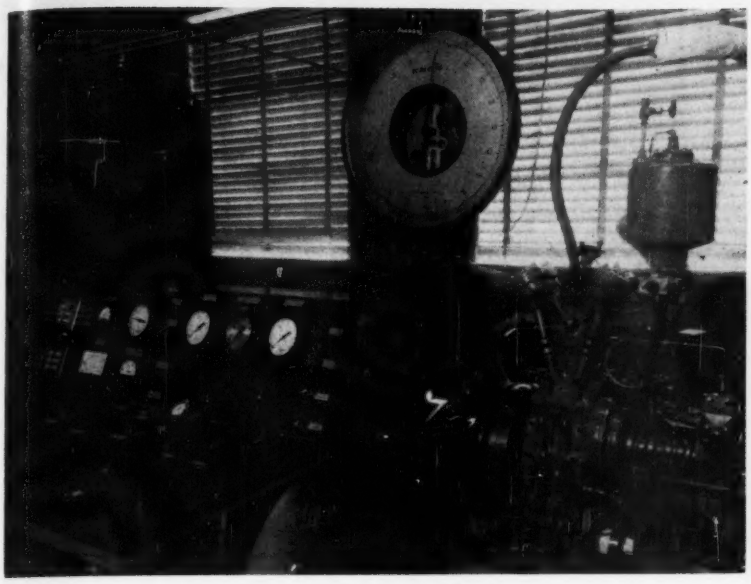
The lubrication system is supplied with a pump which passes oil through a slotted disk filter to the main bearings. A low-pressure relief valve passes oil to the valve mechanism. A heater in the crankcase is supplied for prewarmup lubricant heating.

The humidity, temperature, and pressure of the combustion air are controlled by automatic temperature and pressure regulation. The accompanying diagram will aid in understanding this system. The prefix letter of numbers on the diagram indicates the location of that part in the laboratory: "M" indicates a location of that part on the main control panel; "A" locates parts on the auxiliary panel; "E" locates parts in the engine test room, but not on or closely adjacent to the control panels; and "B" indicates basement locations.

The humidity of the combustion air is controlled by saturating the inlet air at a regulated temperature, and then controlling its humidity through a system of heaters and pressure controls. Cold water is supplied to the system through supply line B-57. The amount of cold water supplied is regulated by a motor-actuated proportioning valve B-58. Operation of this valve is controlled by a resistance thermometer in the top of the separator tank through temperature controller A-60. This temperature controller serves to regulate the air temperature leaving the separator tank. Presetting this valve for the desired air temperature leaving the separator tank will operate motor valve B-58 to maintain this temperature. The cooling water is then pumped to the



UNIVERSITY OF MICHIGAN LIBRARIES



Engine and Control System

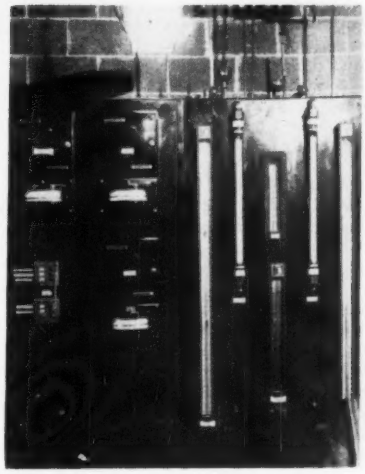
air compressor through line B-56 by the water circulating pump B-79. This water then serves to completely saturate the combustion air leaving the separator tank. To cause the system to stabilize quickly, a 4-kw. heater B-61 and an adjustable thermal switch B-62 are provided in the separator tank. A 0-to-600 F. pyrometer M-301 and selector switch M-302 serve to record the temperature of the various components of the system at the points indicated on the diagram.

The initial pressure adjustment for the combustion air is attained by manually controlling the pressure in the separator tank by air pressure control M-64, which remotely controls air bleed valve B-63. The automatic pressure control consists of an electronic type liquid level pickup unit E-65 that can be set to the desired manifold pressure on manometer E-66. Pickup E-65 actuates controller E-67, which in turn controls motor actuating throttling valve E-68. This is the fine adjustment for manual throttling valve E-28. After adjusting valve E-28 to the desired manifold pressure, any fluctuations in pressure will be automatically compensated by motor actuated throttling valve E-68. Thus, by setting pickup unit E-65 to the corresponding pressure on manometer E-66 and turning on controller E-67, the manifold pressure is automatically maintained. Since the scale on manometer E-66 may be initially set to read barometric pressure, manifold absolute pressures may be read directly from manometer E-66 as well as from manometer A-96.

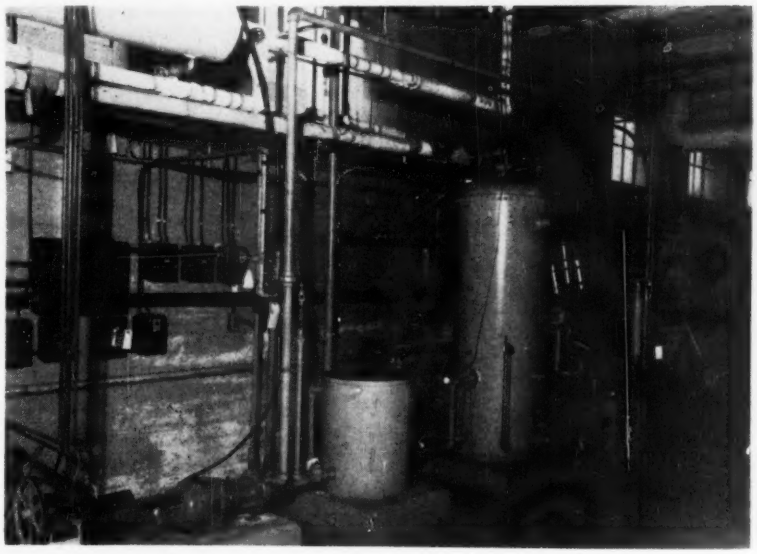
The combustion air leaves the separator tank at the temperature for the desired specific humidiy. The humidity chart for relating pressure, temperature, and humidity in the separator tank, serves as a guide in determining the temperature selection for a desired specific humidity. If the combustion air were cooled at the separator tank outlet (saturation conditions exist at this point), some of the moisture would condense out of the air and the desired result would be lost. Air heaters are provided to avoid this condition. Heater B-69, located in line B-70 just on the outlet of the separator tank, is controlled by thermal switch B-71. This thermal switch can be set to maintain a minimum line temperature above saturation temperature and, thus, loss of moisture in the combustion air will be prevented. From heater B-69, the air flows through line B-70, through air flowmeter B-72, past air heater B-73, and then through throttling valves E-68 and E-28 to the engine manifold surge chamber.

For manifold temperature regulation, control thermocouple E-74 actuates manifold air temperature controller A-75 which in turn regulates the heat input of air heaters B-73 and E-29. Controller A-75 may be preset to any desired manifold air temperature, and it will then automatically maintain that temperature up to the limiting capacity of heaters B-73 and E-29.

The quantity of combustion air delivered to the engine is measured with the multiple-orifice air-flowmeter B-72. Static pressure is read from gage M-76, and the differential pressure across the orifice is read on air-flow manometer A-77 in inches of mercury or air-flow manometer A-78 in inches of water. The air flow can now be determined by the use of a typical air flow equation.



Auxiliary Panels



Basement Controls

REPORT ON WESTERN EUROPE

Third Article--Conclusions on Economic Conditions

By RICHARD RIMBACH, Publisher of *Instruments*

IN the last issue of *Instruments*, the writer completed the pictorial report on his recent trip to England, France, Switzerland and the Western Zone of Germany. In this issue I will report briefly some impressions obtained, at that time, from the few contacts made in these countries. Since I returned from Europe, some of the predictions I planned to make have materialized and will not be included.

My remarks will be confined to four countries: England, France, Switzerland and the Western Zone of Germay.

I planned my trip abroad for the express purpose of looking over the instrument industry and the possibility of European competition from the principal instrument-producing countries.

European Instrument Industries

Economic conditions in Europe are very different from those in the United States. In Europe, capital and material costs are high, labor costs are low. Mass production is not the answer to Europe's problems. Mass production requires high cost machinery (including measuring instruments and automatic controllers) but mass production also requires a mass market. The ideal condition is to parallel mass production with mass distribution. The European has no concept of a mass market, little sense of service and a hazy notion of competition. In brief "America markets, Europe peddles."

However, unfortunately for the United States, the American Instrument Industry is not a mass production industry. This makes it vulnerable for the European instrument industry.

The British instrument industry does not yet find the need for aggressive selling. The number of salesmen per total number of instrument company employees is much smaller in many companies than is the case in Germany or the United States. Usually the sales direction is in the hands of the top company executive (the Managing Director) and the sales manager is largely concerned with the submission of quotations and sales correspondence.

In Germany it has not been a simple matter to relocate East Zone plants in the West Zone due to labor availability. A new Zeiss plant has been built in the Western Zone but although the scientific personnel was available the special technical labor was not available in the new location so that results have been far from satisfactory. Other German instrument manufacturers have had similar experiences.

I visited a few instrument manufacturers in England, France and Germany. From my observations during these visits I feel that, as far as facilities are concerned, there is little difference between the European shops and those in the United States. I saw no reason why the unit production per man should not be the same in all countries visited. If this is true, it would appear that Germany has the greatest advantage as the unit cost would be lowest there. I am convinced that the European worker is just as skilled and just as efficient as our own and that therefore the production per man in product units should be the same as that in the United States.

TABLE 1

Country	*Hourly rate of a First Class Instrument Mechanic*	*Rate of Exchange per dollar in May 1950*	*Hourly rate in dollars*	*Cost of a Pair of Shoes*	*Pack of Cigarettes*
France	140 francs	350 francs	0.40	3000 francs	65 francs
Germany	1.75 marks	4.20 marks	0.42	24 marks	2 marks
England	3.50 shillings	7 shillings	0.50	2 pounds	3.50 shillings
Switzerland	3.50 Swiss francs	4.13 Swiss francs	0.85	40 Swiss francs	0.90 Swiss francs
United States	2.00 dollars		2.00	12.00 dollars	25 cents

Table 1 shows that Germany, England and France can, and will, make instruments much cheaper than they can be made in the United States under present circumstances. By referring to Table 2 we can therefore note that the cost of an instrument in Germany would be 39.6 percent of the American, England 46.6 percent and France 47.5 percent. (The tables do not include two of the American Instrument Industry's most serious foreign competitors—Italy and Japan. Reports which I did not obtain myself, but which I have reason to believe are authentic, indicate that skilled instrument workers in Italy earn 27 cents per hour, and that Japanese instrument workers earn 12 cents per hour.)

An entirely false interpretation has been given to similar comparative data by some U. S. government people, who are interested in promoting lower tariffs. This interpretation is that, owing to the low efficiency of foreign workers, the value of annual production per man is lower than it is in the United States. I do not agree with such an interpretation.

The annual production per man is largely determined by the labor rates paid. It is generally accepted that the percent of labor in instrument manufacturing is 70 percent, so that an instrument which costs 1000 dollars in France should cost 1035 dollars in Germany, 1175 in England, 1780 in Switzerland and 3800 in the United States. The foreign instrument manufacturer has a further advantage in that in many cases overtime is paid at the regular rates.

With the labor cost representing about 70 percent of the total cost of instrument production and the individual production equivalent to that in this country, the low wages of foreign instrument workers are the most decisive factor in increasing the importation of instruments into the United States.

Further, foreign instrument manufacturers do not need tariff reductions to rehabilitate themselves. Many of them, even in Germany, are up to or have exceeded their prewar levels. Instrument production in the West Zone of Germany exceeds the prewar production of the combined zones. The foreign instrument manufacturers have a much longer history than American instrument manufacturers and have had an opportunity to develop technological abilities and know-how.

The reduction of American tariffs at this time would encourage the instrument manufacturers behind the Iron Curtain, in West Germany and, with the possibility of nationalization of all industries, in England.

Foreign competition is unfair when state-controlled industries employ slave labor, currency devaluation, exchange-rate juggling, state trading, and other trade practices which are not and cannot become a part of our system of free competition among private enterprises.

Instrument manufacturers should be careful not to permit construction drawings or pictures to fall into the hands of Russia or any other Iron Curtain countries and Italy, as these countries have a reputation of paying little or no attention to patent rights.

Industrial instrument manufacturers

UNIVERSITY OF MICHIGAN LIBRARIES

in Europe are not set up so that they can compete in the United States with the American industrial instrument manufacturers. This is largely due to the fact that the European instrument manufacturer makes many of the component parts used in his production. The European industrial instrument manufacturer also is in competition with the instrument departments of large instrument users. Not only do these user companies develop and manufacture instruments which operate on new principles, but they also build the "bread-and-butter" items. I gained the impression that instrument manufacturers would have an increased market for measuring instruments and automatic controllers if the instrument user companies did not have to build many of their requirements due to the long delivery promises. One of the user plants had a complete instrument manufacturing shop with 100 employees. I would estimate that the instrument requirements in England would be at least 25 percent larger if this competition ceased. England's instrument industry has an advantage in that she has adopted a policy that no instrument shall be imported if it or a substitute can be made in the United Kingdom.

TABLE 2

Country	*Hours Worked per week without overtime pay****	*National Income Tax*	*Value of Annual Production Per Man*	*Value in Dollars*	*Estimated Value in Dollars of Products produced by the Precision Working Industry**
France	40-53	20 percent	1,000,000 francs	2,850	80 million
Germany	48-51	25 percent	10,000 marks	2,380	300 million
England	44	10 percent	1,000 pounds	2,800	200 million
Switzerland	44-48	10 percent	**	**	60 million
United States	40	20 percent	6,000 dollars	6,000	2 billion

*The Precision Working Industry, as defined in this table covers instruments and devices for measurement, inspection, testing, and control and also includes manufacturers of optical and photographic instruments; timepieces; regulated valves; surveying instruments; and dental, surgical and medical instruments.

**Information of a scientific or trade nature is considered as industrial espionage in Switzerland, as is also the case in Iron Curtain countries as confirmed by the news reports on the American Vogeler.

***The number of hours worked by foreign workers above 40 hours per week without overtime pay gives these countries an additional advantage.

Instrument Departments in England

In the instrument using plants I visited in England, the chemical and petroleum industries were the only ones with instrument departments. These plants are easily instrumented as well or better than our own. Control houses, or rooms, on the drawing boards are quite as elaborate as those in the United States in color scheme and appointments as well as in the instruments mounted on the boards. Accuracy in the instruments, instead of dependability or reproducibility, is required. Owing to this, the instruments require more maintenance and the number of instruments looked after by one instrument man is less than in this country.

There are many small and medium-size plants in Europe that have practically no instruments, as they still depend on the individual worker's ability.

Instrument engineers are usually physicists, who are trained as engineers by the plant instrument department. Also in most plants, a representative of the instrument department is attached to the plant research laboratory, to assist in instrument design and application.

Mechanics, in England, are trained in company-operated schools comparable to vocational schools here. The apprentices chosen by the personnel department attend a school operated within the plant limits. Such schools are under an educational director, who is in close contact with the individual at all times.

Instrument mechanics are recruited from the better apprentices, who complete the required courses in the plant apprentice training schools. Such apprentice training courses are better than any of which I have knowledge in the United States, and are better than our vocational schools and G.I. approved private training schools.

Trade Associations

Trade Associations in Europe are not looked on with suspicion by foreign governments as is the case in our country. These associations are of considerable assistance to their members especially in the promotion of exports. In fact the trade associations in England are recognized by all branches of the British Government as the central organization and the authoritative mouthpiece of the industries they represent.

The associations operate with the government agencies under which applications for import licenses are not granted until the government is satisfied that the device cannot be manufactured by a British company. The associations also are in constant touch with the Ministry of Supply and Board of Trade so that, when the United Kingdom negotiates a trade agreement with another country, there is an adequate and separate quota for the export of British products to that particular market. The associations are consulted by the government on all matters affecting the export of products, such as bilateral and other trade agreements, tariffs, import licensing restrictions, etc.

Quite often, the members exhibit as a group, as was the case with the Scientific Instrument Manufacturers' Association at the British Industries Fair and also at Canadian International Trade Fair. Often such cooperative action results in the preparation of export catalogs or the organization of active export committees. Such export committees have liaison with trade organizations, embassies, chambers of commerce, consuls, commercial attaches and trade delegations in various parts of the world.

Below I am listing the trade associations which are in whole or in part made up of manufacturers of instruments and devices for measurement, inspection, testing and control.

The British instrument industry subscribes about one-fifth of the cost of the activities of the British Scientific Instrument Research Association. The balance is obtained through a British government grant from the Department of Scientific and Industrial Research.

ENGLAND

British Electrical and Allied Industries Research Association, Instrument Section
British Industrial Measuring and Control Apparatus Manufacturers' Association
British Lamp Blown Scientific Glassware Manufacturers' Association
British Scientific Instrument Research Association
Drawing Office Material Manufacturers' and Dealers' Association
Gauge & Toolmakers' Association of Great Britain
Radio & Electronic Component Manufacturers Federation
Scientific Instrument Manufacturers' Association

FRANCE

Syndicat des Fabricants d'Appareils Electriques
Syndicat des Fabricants d'Appareils de Regulation et de Controle
Syndicate de la Robinetterie (Manometres et Thermometres)

GERMANY

Fachgemeinschaft Pruefmaschinen
Verein Deutscher Maschinenbau Anstalten
Verband fuer Messgeraete und Werkzeuge
Wirtschaftsverband Feinmechanik und Optik
Zentral Verband der Elektrotechnische Industrie, Fachverband Messgeraete und Zaehler and Fachunterband Elektronische Messgeraete

Foreign instrument manufacturers are not kept out of the American market nor are they prevented from earning dollar exchange. The writer has advocated that foreign companies license American manufacturers or establish American subsidiaries. It would be much better for Europe as well as the United States to export ideas and create dollar balances from royalties.

No. 43—Product of
Moth-King Corporation
Detroit 23, Michigan

This efficient "Moth-King" electrical insect destroyer depends on Chace Thermostatic Bimetal for the sure control of operating temperature that has earned it U/L approval.

Operation is simple; after the cord is plugged in, a light push on the starting button forces contact-carrying spring upward until it latches on a bimetal strip, which carries the other contact. This closed circuit is maintained until inside temperature reaches 180°F, causing the bimetal to bend upward, releasing the spring to break the circuit. The heat evaporates crystals of paradichlorobenzene, maintaining a saturated atmospheric condition in properly sealed closets for 10 to 15 hours, during which *all* fabric-eating insects therein have been destroyed.

In *this* case, Chace Thermostatic Bimetal chases actual bugs . . . in *every case*, it chases operating "bugs" out of products that present control difficulties. When design of *your* product presents problems related to thermostatic control or response, call in the man best qualified to make design recommendations. He's the Chace Application Engineer . . . and he can help you! We invite your inquiry.

W. M. CHACE CO.
Thermostatic Bimetal
1609 BEARD AVE., DETROIT 9, MICH.

CALIBRATION OF GAS FLOWMETERS

(Especially for High Flow-rates)

By ALBERT E. SCHULER, Fort Bliss, Texas

A NEW method for accurate calibration of gas flowmeters at high flow-rates is described. By this method mass flow rates of gases may be determined within an accuracy of 0.3 percent.

The measurement of the mass-flow rate of gases is a rather complex problem in itself and a reliable calibration of gas-flowmeters entails even more difficulties and errors. A calibration should be based on well-defined standards, such as the dead-weight tester which reduces the pressure calibration in measurement of weight and area. Flowmeters for liquids can be calibrated by determining weight and time, but in calibrating gas flowmeters it is impossible to weigh the gas accurately because of the relatively high weight of the tanks. On the other hand, a volumetric measurement requires the additional determination of the density —which often involves the greatest error in flow-rate measurements of gases.

One commonly-used calibration method provides a gas supply of constant volume. Pressure and temperature of the gas are measured either as functions of time or before and after the calibration. The change of the density of the gas determines the mass of gas used in the time unit. Measuring the temperature as function of time becomes more inaccurate with increasing gas expansion because the temperature equalizes too slowly. Measuring the density before and after calibration requires constant flow-rate from the very beginning throughout the calibration; this is impossible because of the regulating procedure at the beginning. Both methods require an extremely large gas supply to minimize expansion or to permit a long period of calibration with a minimum of time lost in making regulations or adjustments at other than constant flow rate. At higher flow rates, say of the order of 10000 cfm., the handling of the required gas volume would become costly.

Similar errors and difficulties are encountered in other volumetric calibration methods, especially where higher flow rates are involved.

Another method often used is the comparison of the subject flowmeter with others which have been calibrated or are based on standards given by the American Society of Mechanical Engineers or by the International Standards Association. This however, is not a calibration.

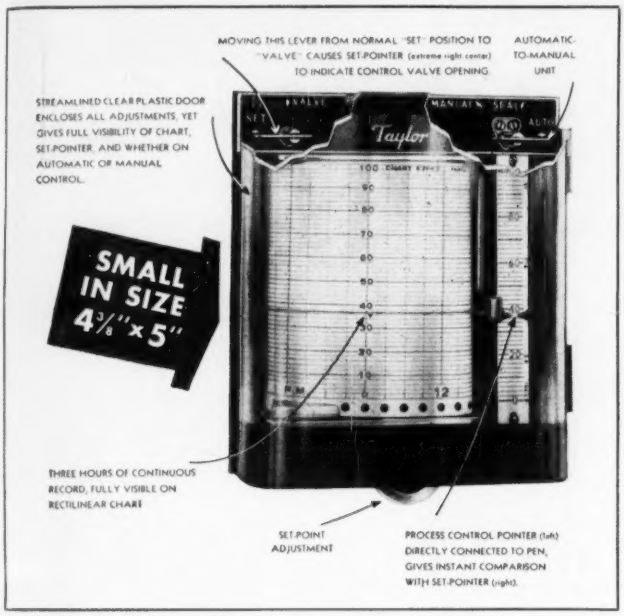
The calibration method described here uses a highly accurate volume versus time measurement with constant density. The method calls for the required gas supply in tanks under a certain pressure and equalized ambient temperature. The gas is displaced by water without changing pressure and temperature of the gas. The volume of gas and the time required to displace it by the same volume of water are determined by means of the "Multiple Measuring Tank Principle" as described and explained below.

Principle

There are two columns of tanks. The tanks of each column are connected to one another by short pipes and the two columns are connected at the bottom by another pipeline. Each column is connected to a compressed air supply. The flowmeter to be calibrated will be connected on top of column 2. Column 2 will be filled with gas at a pressure determined by the quantity of gas required for the calibration. The temperature of the gas must be uniform and calibration must be delayed until temperatures have become equal throughout the system. Column 1 is filled with liquid which is forced by compressed air or pumps from column 1 to column 2, displacing the gas without changing its pressure or temperature. The water pressure or flow rate must be regulated according to the gas flow-rate and gas pressure selected. Constant flow conditions should be reached as

UNIVERSITY OF MICHIGAN LIBRARIES

Taylor's New Midget TRANSET* RECORDER


MOVING THIS LEVER FROM NORMAL "SET" POSITION TO "VALVE" CAUSES SET-POINTER (extreme right center) TO INDICATE CONTROL VALVE OPENING
AUTOMATIC-TO-MANUAL UNIT
STREAMLINED CLEAR PLASTIC DOOR ENCLOSES ALL ADJUSTMENTS, YET GIVES FULL VISIBILITY OF CHART, SET-POINTER, AND WHETHER ON AUTOMATIC OR MANUAL CONTROL.
SMALL IN SIZE 4⅜"x5"
THREE HOURS OF CONTINUOUS RECORD, FULLY VISIBLE ON RECTILINEAR CHART
SET-POINT ADJUSTMENT
PROCESS CONTROL POINTER (left) DIRECTLY CONNECTED TO PEN, GIVES INSTANT COMPARISON WITH SET-POINTER (right).

Gives continuous 30-day chart record on 4⅜" x 5" panel space

PLUS

1. Automatic-manual unit
2. Remote set-point adjustment
3. Valve position indication
4. Chart re-wind mechanism (optional)

THIS tiny (4⅜ x 5") pneumatic TRANSET RECORDER for flow, liquid level, pressure and temperature, greatly simplifies the most complicated central control problems. It indicates and records in the same space required by a conventional-sized indicator alone. And it eliminates receiver wings on even the most up-to-date central control panels (particularly graphic panels).

HERE ARE A FEW UNIQUE ADVANTAGES:

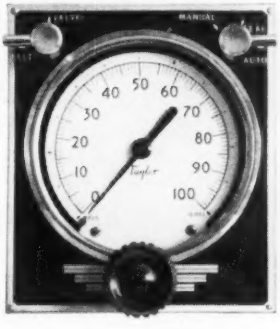
1. ***Easily removable chart-drive mechanism for re-loading.***
2. ***Scale shows actual transmitter process range —is graduated 3-15 psi. for checking calibration and valve position.***
3. ***Automatic-to-manual feature gives easy start-up—makes it easy to service controllers.***

You Can Get These Four Models: (1) One process record, set-point indication, set-point adjustment, valve position indication, and automatic-to-manual unit. **(2)** One process record, valve position indication, and remote manual valve loading. **(3)** One process record only. **(4)** Transet Indicator (below).

For Complete Details, Send for Bulletin 98079. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.*

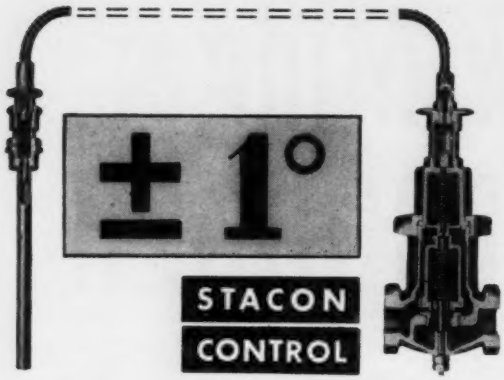
TRANSET INDICATOR

Fits into the same panel cut-out as TRANSET RECORDER. Many parts interchangeable with TRANSET RECORDER. Available with or without Automatic-Manual and remote control point setting.



*Reg. Trade-Mark

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST



Temperature regulation to plus or minus one degree F. is the unheard-of accuracy obtainable with the self-operated Farris Stacon Temperature Regulator.*

Two design factors are responsible:

1. Liquid in bulb flashes to vapor in power bellows — steam does 99 per cent of the work . . . without appreciable time lag.
2. Full balancing bellows has the effect of double seated operation with single seated valve. eliminates spring counterpoise and all packing glands. provides free-floating valve disc. prevents response to variations in steam temperature.

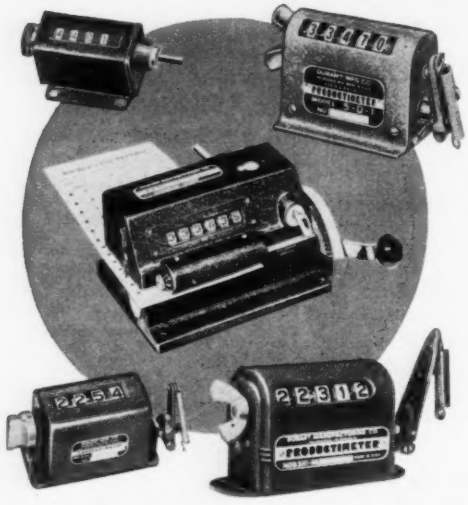
Stacon Regulators are compact, trouble-free, dirt-proof. They operate consistently in the worst possible surroundings and require no maintenance.

You'll want to learn more about the most sensitive, accurate, economical temperature regulator on the market. Write for Stacon Bulletin 50-1000.

*PATENTED

farris stacon CORPORATION

436 COMMERCIAL AVE. PALISADES PARK, N. J. 6689



Productimeters register accurate count of every unit processed . . . eliminate profit-eating losses . . . insure economical plant operation and maximum use of man hours.

Send for Catalog No. 100

DURANT MANUFACTURING CO.

1914 N. Buffum Street, Milwaukee 1, Wisconsin — 114 Orange Street, Providence 3, R. I.

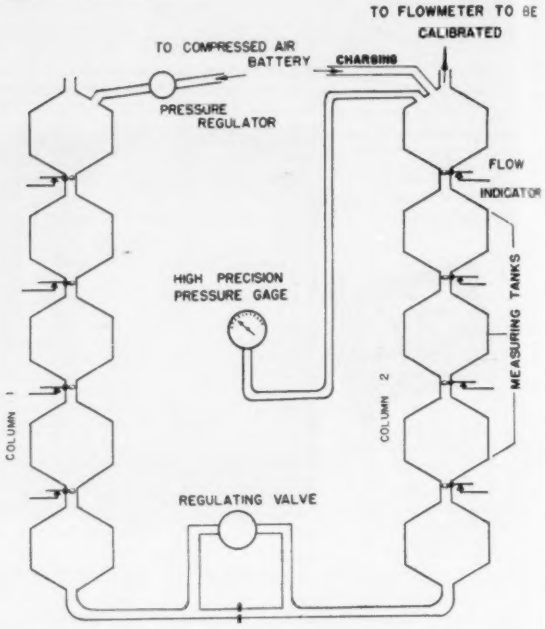
Representatives in Principal Cities

PRODUCTIMETERS

SINCE 1879 — Speedometers OF INDUSTRY

soon as the lowest tank of column 2 is filled with water. When the water level passes the connection tube to the second tank, a flow indicator transmits an impulse to a time recorder. The same is done by other flow indicators when the water level passes the connection tubes between other tanks. The time recorder measures the time required to fill each tank and, since the capacity of each is predetermined, the volume-flow rate can be calculated. The density is accurately controlled and the actual mass-flow rate can be determined.

The volume flow rate can be measured in the same way at the same time in the tank column 1 which would give a double check on the accuracy of the measurements. One of the columns could be replaced by any other tank arrangement if that double check is not considered important. This might reduce expenses.



The following types of flow indicators may be used:

(a) A photoelectric device consisting of a phototube and a source for a light beam. The beam enters the medium in the pipe at an angle. As long as gas is between the light source and the phototube, the beam is incident upon the phototube. When the water level passes, the beam becomes deflected by reason of the different coefficients of refraction of gas and water and is no longer incident upon the phototube.

(b) A baffle plate which responds to the different dynamic impact of gas and water and operates an electrical contact when the water level passes.

Tests have shown that both devices have a speed of response faster than 0.1 second.

The tanks should be spherical or funnel-shaped at bottom and top in order to insure an exact jump from water flow to gas flow at the flow indicator. Otherwise, gas pockets may remain in the corner of the lower tank while water already flows in the upper tank in column 2 or water funnels may decrease the accuracy in column 1.

With tanks of the shape described and with a reasonable flow velocity in the connecting tubes, say of the order of five feet per second, the volume-flow rate can be determined as accurate as the flow indicators plus time recorder measure the time required to displace the gas in each measuring tank. As previously stated, the flow indicators have a speed of response within 0.1 second. Since the time interval is determined by the impulses from two flow indicators, the probable time error is 0.2 seconds. Assuming a calibration time of 100 seconds and a negligible error in the determination of the tank volumes, the probable error of the volume flow rate is 0.2 percent.

Naturally, this method requires a constant flow rate because volume and time are measured spasmodically. This way only the average flow rate can be determined in case the flow rate varies. Therefore, there must be at least

UNIVERSITY OF MICHIGAN LIBRARIES

DO YOU HAVE AN INSTRUMENTATION PROBLEM?

Bendix-Pacific telemetering facilities can provide you with any phase of a complete instrumentation service. These include:

- ★ The standard AN/DKT-3 subminiature telemetering components which remotely measure and indicate acceleration, motion and position, pressure, strain, temperature, vibration, velocity, voltage and current. Transmitters up to 15 watts of power are available.
- ★ Application engineering to adapt the Bendix-Pacific System to each specific problem.
- ★ Installation and calibration services.
- ★ Aircraft and missile antenna design and radiation analysis.
- ★ Flight testing, providing all ground station facilities and reduction and analysis of data.

RADAR BEACON

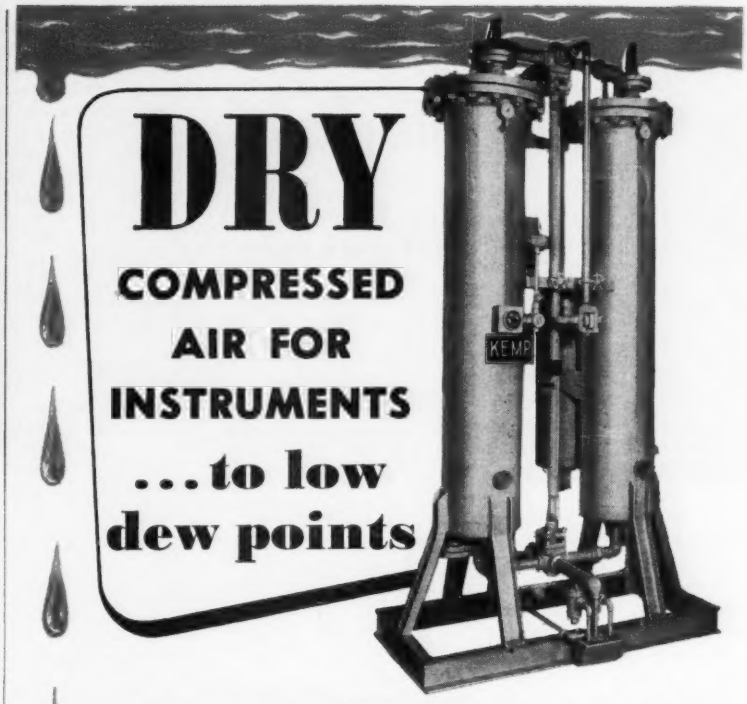
Bendix-Pacific has developed for restricted use an exceptionally small, compact radar beacon for use in the common radar bands to facilitate vehicle tracking.

Inquiries from qualified companies and agencies for complete engineering data are invited.

Pacific Division
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIFORNIA

Eastern Engineering Office: 475 Fifth Ave., N. Y.

TO MEASURE—TO INDICATE—TO WARN AT A DISTANCE



DRY COMPRESSED AIR FOR INSTRUMENTS ...to low dew points

Here's how KEMP Dynamic Dryers protect instruments, control moisture in instrument air at Low Cost!

COMPACT, inexpensive, standardized — that's the story behind Kemp Oriad *instrument* air dryers. Designed specifically for instruments, these dryers limit moisture content in instrument air to safe dew points! Operation is *uninterrupted*. One single lever changes flow and reactivation is accomplished automatically. Oriad Dryers are available in standard drying cycles.

DESIGNED FOR INSTRUMENTS

Kemp Dynamic Dryers are versatile—offer *manual*, *semi-automatic* or *automatic* operation. Drying to any *dew point you specify* is guaranteed, at an extremely low cost! Desiccant is selected especially for instrument work to provide effective moisture control. Choose gas, electric or steam regeneration as standard equipment.

SEND FOR INFORMATION

Whether your moisture control problem is special or standard, you'll find Kemp has a Dynamic Dryer especially designed to solve it. Find out how Kemp engineering can save you money. Get the facts on Kemp Dynamic Dryers. Bulletin D-27, contains specifications, technical data and full information. For free copy, mail coupon today!

KEMP OF BALTIMORE

DYNAMIC DRYERS

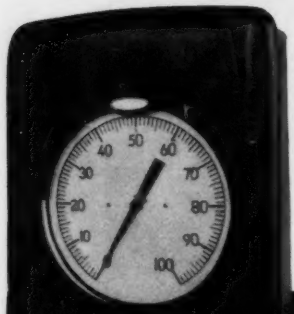
CARBURETORS
BURNERS
FIRE CHECKS
ATMOSPHERE & INERT GAS GENERATORS
ADSORPTIVE DRYERS
METAL MELTING UNITS
SINGEING EQUIPMENT
SPECIAL EQUIPMENT

THE C. M. KEMP MFG. CO., Dept. J-9
405 E. Oliver St., Baltimore 2, Md.

Gentlemen: Please send me Information Bulletin D-27. We want facts on drying ( ) air ( ) gas ( ) liquids.

Name .....
Company .....
Address .....
City ..... Zone ..... State .....

BALDWIN Concentric-Pointer



STRAIN INDICATOR FOR SR-4* STRAIN GAGES

EASY READING
SELF BALANCING

For use with SR-4 Strain Gages. Operates a pointer over a range of 270° on a 10″ dia. scale, permits values to be read from a distance, without need for additional observer. Provision included for zero and gage-factor adjustment, and for selection of one, two or three desired ranges. Automatic bridge balancing. THE BALDWIN LOCOMOTIVE WORKS, Philadelphia 42, Pa., U.S.A. Offices: New York, Houston, St. Louis, Chicago, Cleveland, San Francisco, Washington, Pittsburgh.

*T.M. Reg. U.S. Pat. Off.

TESTING HEADQUARTERS **BALDWIN**

5815

"Veeder-Readings" ARE DIRECT READINGS

...THAT MINIMIZE CONVERSIONS, ERRORS, DELAYS

Put an end to the setting and reading of hairline-graduated dials on all types of machines.

Install a Veeder-Root Counting Device that will give direct and accurate *Count*rol over rate of feed, depth of cut, or any other phase of operation.

Then operators and inspectors get their Facts-in-Figures directly, plainly, *unmistakably*... in bold, easy-to-read figures that don't have to be converted, decoded or otherwise translated.

2217125

The Counting House of Industry

VEEDER-ROOT INC.

Hartford 2, Connecticut

In Canada: Veeder-Root of Canada, Ltd., 955 St. James St., Montreal 3. *In England:* Veeder-Root Ltd., Dickinson Works, 20 Purley Way, Croydon, Surrey.

three tanks in the column. The gas volume of the first tank is required for the starting procedure until constant flow rate is achieved and this gas volume must not be used for the measurement. The second tank is the measuring tank and may be much larger than the others. The last tank is not used for measurements but for the run-out procedure. The measuring tank in the middle may be split up into several tanks in order to have additional checks between the actual calibration period. In Fig. 1, three measuring tanks plus one tank for the starting procedure and one tank for the run-out procedure are provided.

The measurement of the density is the most difficult task with this method as well as with other methods; but the difference is that *the difficulties are shifted from temperature control to pressure control.* Calibration is delayed until the temperature of the gas in the measuring tanks is uniform and has reached ambient temperature. Only a change in pressure will change that temperature. If the pressure is kept constant, the gas temperature can be measured at one spot and recorded with an accuracy better than 0.1 percent of the absolute temperature.

Accurate control of gas pressure requires that gas consumption be kept as constant as possible to hold the regulating range within close limits and to avoid oscillations which would be difficult to overcome because of the large volume. As explained above, the gas flow rate also must be kept constant for accurate determination of the volume-flow rate.

Methods of keeping the flow rate constant will depend on the particular conditions and arrangements. The flowmeters for which this calibration method was developed are mounted on trailers with other test equipment. The trailer can be moved to the calibration site and be calibrated under original working conditions. This is favorable because the flowmeter is calibrated under the same flow conditions as exist for the normal measuring activities. It has the additional advantage that the normal facilities of the test set-up on the trailer can be used for regulating the gas flow rate. In other cases additional regulating devices will be necessary. The most favorable device for constant gas flow rate will be a sound nozzle, where gas conditions and velocity remain constant at values determined by the critical pressure ratio. Since the gas pressure in the measuring tanks can be selected in a wide range, it should be possible in most cases to handle the high gas expansion and pressure loss required for a sound nozzle.

The second requirement for accurate control of the gas pressure is to regulate the water flow from column 1 to column 2. To avoid larger fluctuations, 95% to 98% of the water should pass through a main duct with a calculated nozzle or a regulating valve positioned for that flow rate. The remaining 2% to 5% of the water flow is regulated in a bypass by a manually operated valve. After some experience the pressure can be regulated within 0.3% if it is indicated by a high-precision pressure gage having an accuracy of 0.2%. Such accuracy cannot be reached by an automatic regulator.

The overall accuracy of the calibration is determined by the following percentage errors of components, to be measured for the determination of the mass flow rate:

$$r_V = 0.2\% = \text{error of volume flow rate}$$
$$r_T = 0.1\% = \text{error of gas temperature}$$
$$r_P = 0.3\% = \text{error of gas pressure}$$

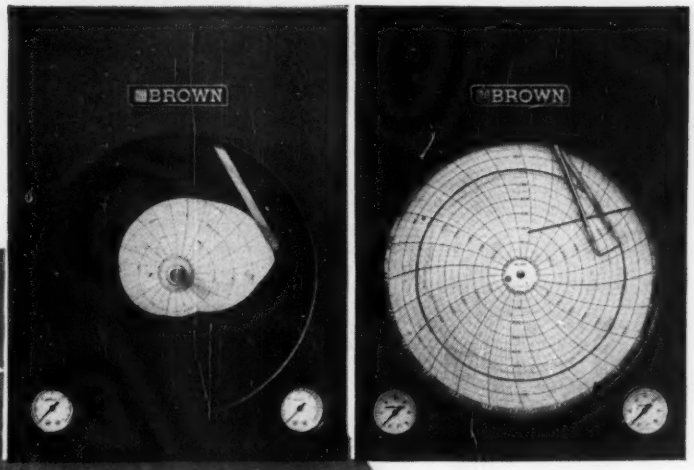
According to the law of propagation of errors, the percentage error of the mass-flow rate is:

$$r_W = [(r_V)^2 + (r_T)^2 + (r_P)^2]^{1/2}$$
$$= [0.4\% + 0.1\% + 0.9\%]^{1/2} = 0.37\%$$

The percentage error of the volume-flow rate can be decreased by using larger gas volume, which increases the calibration time. If, further, the high-precision pressure gage is recorded by a camera and the average pressure is determined within 0.2 percent, the accuracy of the calibration can be increased to better than 0.3 percent.

Acknowledgement. The author expresses his appreciation to Mr. R. Beichel for designing a calibration stand based on the calibration method outlined above. Mr. Beichel made many proposals improving the practical performance of the calibration.

UNIVERSITY OF MICHIGAN LIBRARIES



CONTROL

Maintains TEMPERATURE, PRESSURE, FLOW *or* LIQUID LEVEL *in exact accordance with a pre-set schedule*

THE temperature of a crystallizing kettle, the pressure in a retort, the flow of liquid from a tank, the temperature in a cooking vessel—all can be scheduled to an exact program with the Brown *Time-Pattern* Control System.

This Brown control system is ideal, for example, for those processes which best proceed when the temperature is increased gradually or quickly to a specified high value, held at that value for a definite length of time, and then decreased at a determined rate . . . all stages based on timed periods. Use of the system in such a process assures uniform quality of product in batch after batch—now, next week or next year with unfailing accuracy.

The Brown *Time-Pattern* Control System is comprised of a pattern transmitter and a recording controller. The pattern transmitter uses a rotating cam which can be easily cut with shears and accurately shaped to provide the desired control program. As the cam rotates, a follower arm, riding on the edge of the cam, causes the output air pressure from the transmitter to vary. This pressure is transmitted through pneumatic tubing to a receiving unit in the controller.

The system is extremely flexible in that the instruments can be located side by side or spaced apart up to 1000 ft. . . . at the convenience of the user. Distant installation is simplified by use of a single length of copper tubing connecting the instruments.

Call in your local Honeywell engineer for further details on this result-producing control system . . . he is as near as your phone!

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4482 Wayne Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

CONTROL SYSTEM

MINNEAPOLIS Honeywell

BROWN INSTRUMENTS

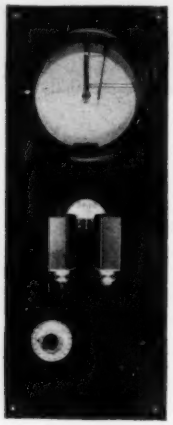
The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions.

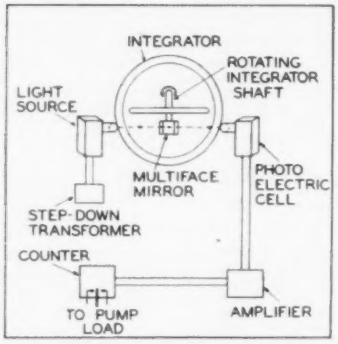
FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 963

Batch Integrator Controller

New liquid batching system uses modification of maker's electric flowmeter. Watthour-meter-type integrator is equipped with rotating multi-face



mirror, which transmits light pulses to photocell as it rotates. When preset number of pulses is accumulated on counter, electric circuit is energized to

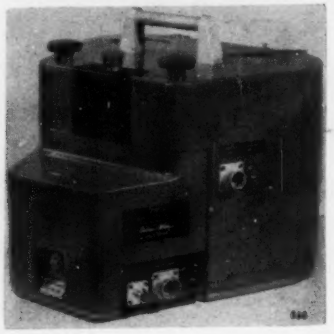


operate pump or other device, and counter resets for next operation. Batch control range is varied by changing number of faces on revolving mirror. —*Republic Flow Meters Co., 2240 Diversey Pkway., Chicago 47, Ill.*

Mention No. 1101 when filling out card.

High-speed Photographic Recording Systems

New "Temporal Sequence System" based on slit-type camera techniques records time sequence past or within a vertical plane passing through optical axis of lens. Equipment automatically records, on same film, electronically-timed numbers showing elapsed seconds and hundredths with intermediate pips spaced at thousandths. Accuracy of markings is 0.002 percent. Continuously-variable film speed in either direction permits recording events progressing in either direction and at speeds up to 2000 mph. in standard unit. For non-optical event, electrical pulses can be fed to system and recorded on film in significant relation to printed time sequence. Printer dials accumulate

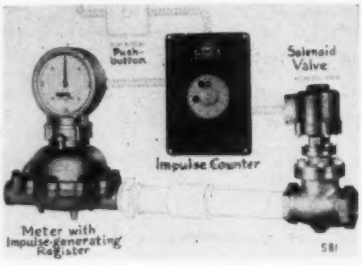


1000 seconds per turnover. Longer time periods are handled by an independent tally of total number of such periods. External time-standard pu'ses can also be applied to synchronize the timer with events occurring elsewhere. System includes a timer-control unit and a power-supply unit, each 14 x 21 x 13 in. Camera dimensions are 13 x 13 x 10 in.—*Beckman & Whitley Inc., 930 San Carlos Ave., San Carlos, Calif.*

Mention No. 1102 when filling out card.

Liquid Batching System

New "Electrivolume Control System" uses fluid meter which generates an electric impulse on delivery of unit

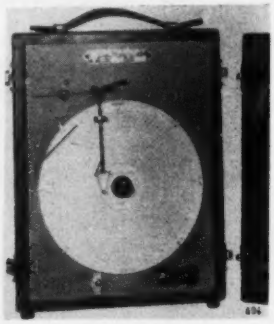


flow. Pulse counter accumulates impulses up to preset quantity, then closes solenoid valve and recycles to zero. Fluid meter pulse generator can also operate remote integrator.—*Buffalo Meter Co., Buffalo, N. Y.*

Mention No. 1103 when filling out card.

Direct-writing D-c. Recorder

New "Type FA-194" portable recorder has minimum range of 100 microamperes and maximum of 5 amp., provided by interchangeable coils.

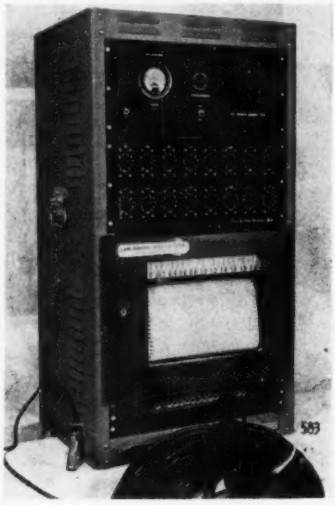


Range of each coil may be altered in ratio of 10 to 1, by adjustable pen arm weight. Sensitivity is 1 part in 1000 of full scale range. Chart is driven by synchronous motor, and another motor flexes pivot bearings and taps chart plate. Hard-wood case is 13 x 10 x 5.5 in., weight is 10 lb.—*Wallace and Tiernan Products, Inc., Belleville, 9, N. J.*

Mention No. 1104 when filling out card.

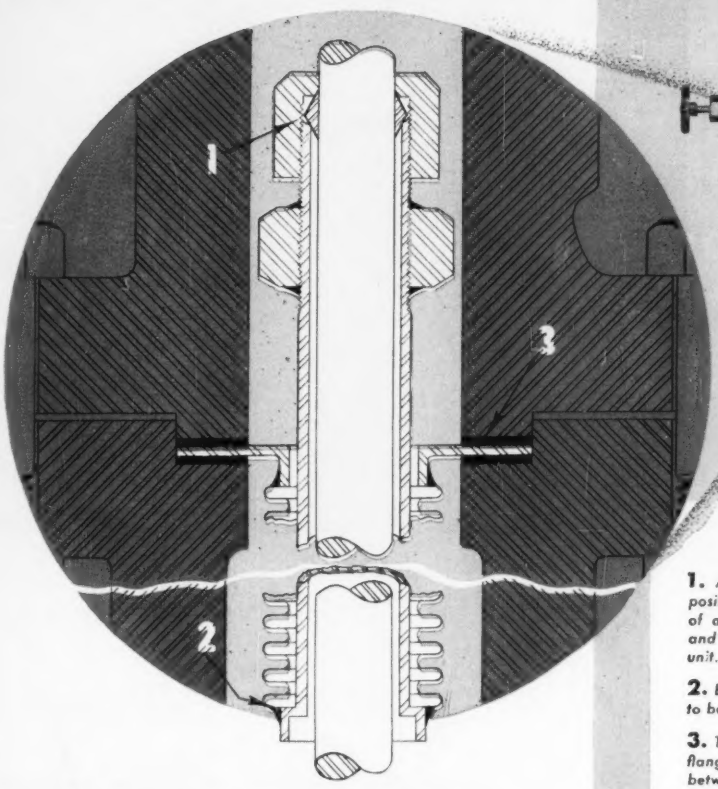
Multi-channel Temperature Recorder

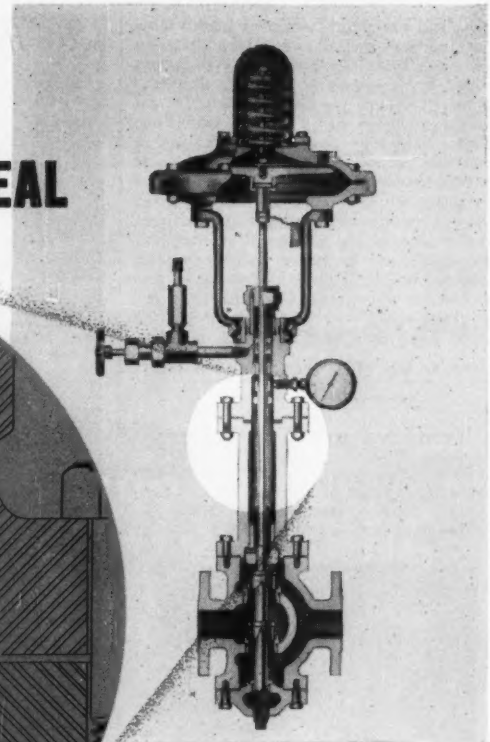
New 16-channel micro-temperature recorder, for measuring temperature gradients of large masses, consists of balanced bridges with 10 contact-point switches for overlapping scale range;



UNIVERSITY OF MICHIGAN LIBRARIES

NOW! Stabilflo Valves with NEW, POSITIVE BELLOWS-SEAL





● Here's an automatic process control valve with a positive, safe, yet *simply-constructed* seal . . . for use wherever toxic, corrosive or precious fluids are involved. The Foxboro Stabilflo Valve is now available with a new-design, bellows-sealed valve stem. Instead of the conventional stuffing box, the packless bellows assembly makes a positive seal between the valve stem and valve body. The bellows expands and contracts with reciprocating action of valve stem.

Over the past nine years, Foxboro has pioneered in the development and application of bellows-sealed control valves for *special* jobs. This improved design is the outcome! It removes bellows-sealed valves from the class of "specials" because of its unique simplicity.

FEATURES

1. *A close-clearance liner guide is positively sealed to valve stem by means of a stainless steel compression ferrule and locknut. Stem and liner move as unit.*

2. *Bottom of liner guide is seam-welded to bottom of bellows.*

3. *Top of bellows is seam-welded to flange, which in turn is gasket-sealed between valve bonnet and bellows housing.*

Bellows assemblies are made of Type 347 Stainless Steel. *Replacement involves only the bellows and ferrule . . .* readily accomplished in field.

The new-design bellows-seal assembly can be applied to any standard Stabilflo Valve in sizes through 4 inches.

See how many advantages involving safety and economy are offered you by this new development. For complete details write **The Foxboro Company, 46 Neponset Avenue, Foxboro, Mass., U. S. A.**

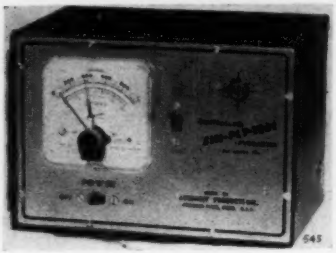
FOXBORO REG. U. S. PAT. OFF. **INSTRUMENTATION**

electrical recorder (modified L&N) with motor-driven switch connecting primary elements from No. 1 to No. 16 to print-wheel which prints (almost simultaneously) corresponding symbols on slowly-moving strip chart; stabilized power supply; and quick-responsive thermal primary elements with cables in lengths up to 500 ft. Instrument has an accuracy of 0.1 F. and is designed for accurately measuring temperatures and gradients for industrial or chemical processes, air or water measurements, motors, etc. Equipment can be furnished for more than 16 channels or for single-channel work.—*G. M. Mfg. Co., 50 W. 3rd St., New York 12, N. Y.*

Mention No. 1105 when filling out card.

Temperature Controllers

New "Simplytrol" temperature controller is provided with automatic protection from thermocouple burn-out. Eight standard ranges cover –75 to

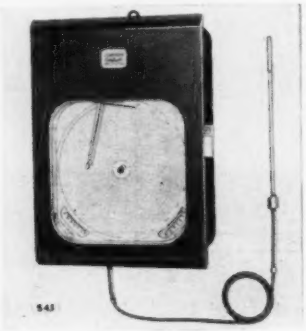


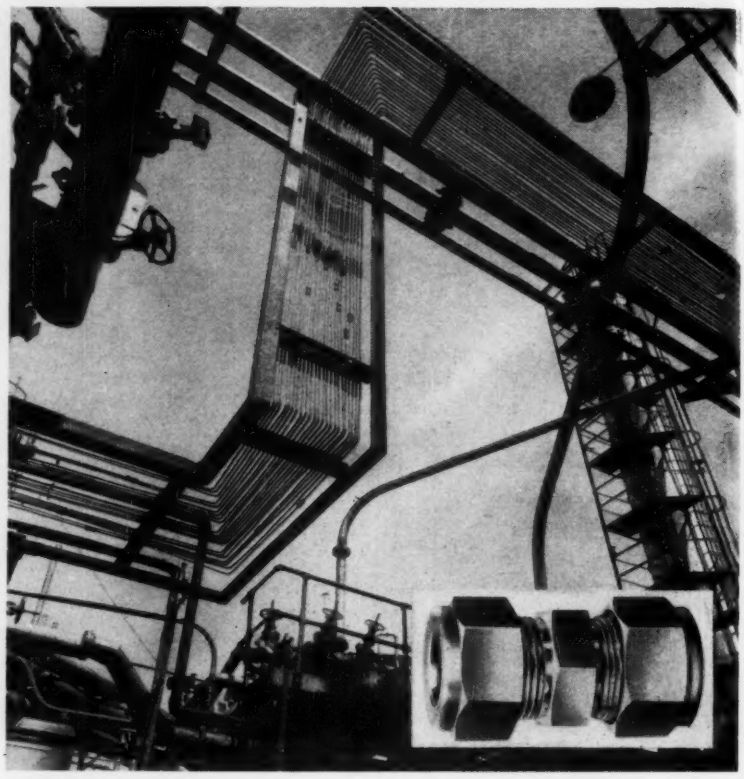
3000 F., direct reading, in both F. and C. with calibrations for I-C, C-A, and Pt. couples. Control action is obtained by direct contact in indicator movement with relay operating directly into load switch.—*Assembly Products, Inc., Chagrin Falls, Ohio.*

Mention No. 1106 when filling out card.

Temperature Recorder-Controller

New "Record-O-Stat" proportional-action temperature recorder-controller may be operated with direct or reverse-action to control air or liquid temperatures. Throttling range is adjustable up to 100-percent chart range, which may be augmented with automatic reset if needed. Using 12-in. charts, 5 standard ranges from 0 to 250 F. are available with ranges between 125 and 400 F. on special order. Capillary tubing is





Perfect Partners...
Aluminum Tubing and
Swagelok* Fittings

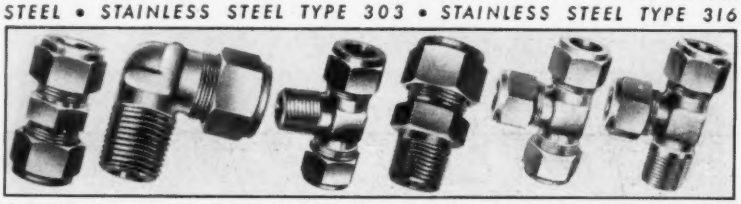
Behind control boards are miles of aluminum tubing, as this instrumentation at Sohio's Latonia Refinery graphically illustrates. The wizardry of instrument men in the use of aluminum tubing demands that "perfect partner", Crawford Swagelok fittings. They're aluminum, of course, to prevent galvanic action.

Instrument men prefer Swagelok fittings because of the speed of assembly. No flaring of the tubing is necessary. Simply insert tubing in completely assembled, finger tight fitting and tighten one and one quarter turns. No torque is transmitted to the tubing in assembly. Bothersome small leaks are completely eliminated because Swagelok fittings are vacuum tight. Free catalog available . . . write for it today.

*Patented

CRAWFORD FITTING COMPANY
884 E. 140 STREET · CLEVELAND 10, OHIO

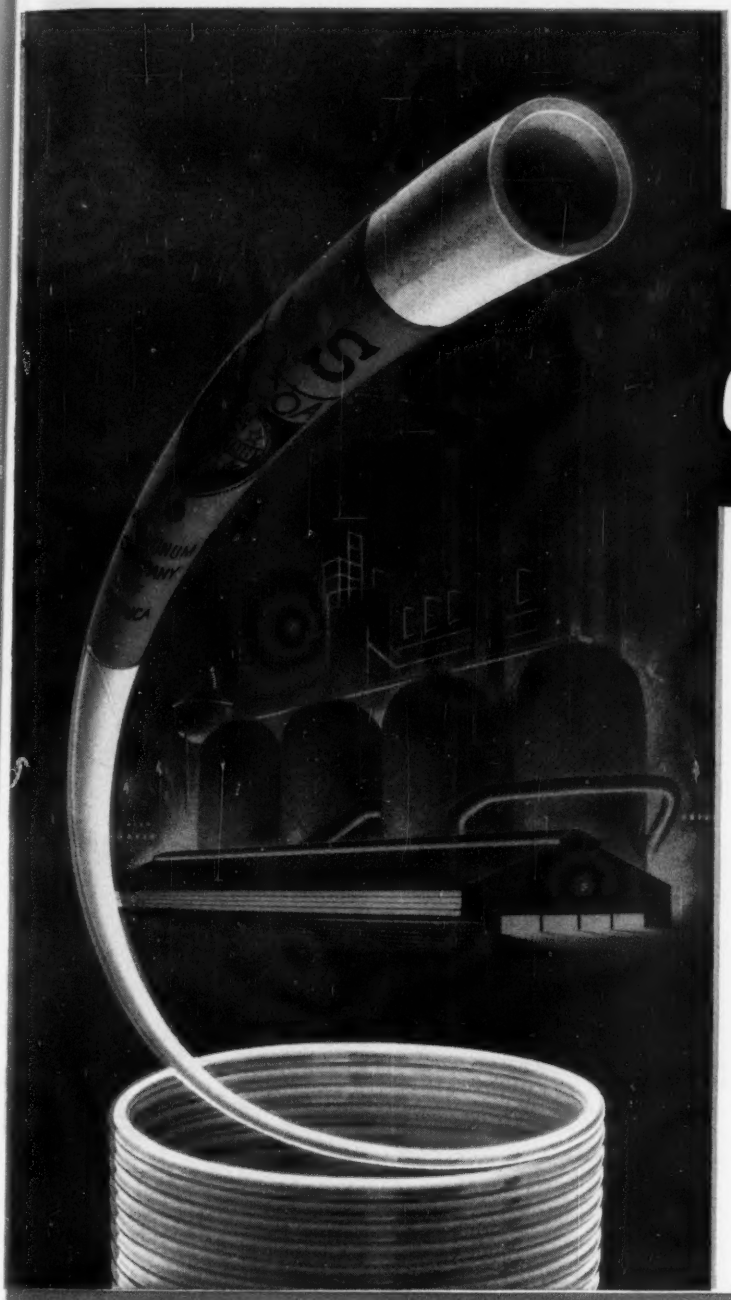
SWAGELOK FITTINGS AVAILABLE IN: BRASS • MONEL • ALUMINUM
STEEL • STAINLESS STEEL TYPE 303 • STAINLESS STEEL TYPE 316



COME TO YOU COMPLETELY ASSEMBLED, FINGER TIGHT

UNIVERSITY OF MICHIGAN LIBRARIES

ALCOA ALUMINUM TUBING



resists industrial atmospheres

CUTS TUBING COSTS 40%

Alcoa Aluminum Tubing resists corrosion by industrial atmosphere that eats away other metal tubing—yet Alcoa Coiled Tubing can cut your tubing costs by as much as 40%!

Strong, light in weight, easily worked, Alcoa Aluminum Tubing comes in lengths to 400 feet, or longer, in popular diameters. Aluminum fittings are available from nationally-known manufacturers.

Phone your nearby Alcoa sales office for complete information, or write ALUMINUM COMPANY OF AMERICA, 2169J Gulf Building, Pittsburgh 19, Pennsylvania.

WRITE FOR FREE ILLUSTRATED BOOKLET

Get Alcoa's new, fully illustrated question and answer booklet about Alcoa Aluminum Tubing. It's crammed with facts about this lower cost tubing for instrumentation lines, applications, physical and mechanical characteristics, other information. Free . . . write for it today!

ALCOA

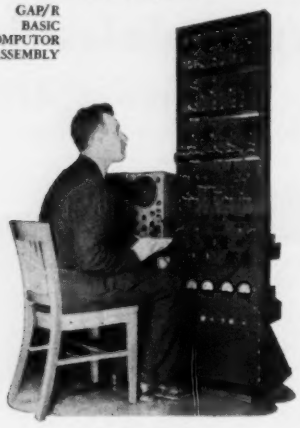
ALCOA *Aluminum* TUBING

UNIVERSITY OF MICHIGAN LIBRARIES

A Compact Analog Instrument that *GROWS* with Your Computing Needs

Private laboratories, educational institutions, and public research establishments can well afford the benefits of an ultra-modern GAP/R Computor. This "building-block" computor, pronounced by authorities to be a superior tool of study and development, operates automatically at electronic speeds, with no moving parts . . . provides you with flexible and basically useful equipment which may be expanded indefinitely merely by adding standard GAP/R Components.

GAP/R BASIC COMPUTOR ASSEMBLY



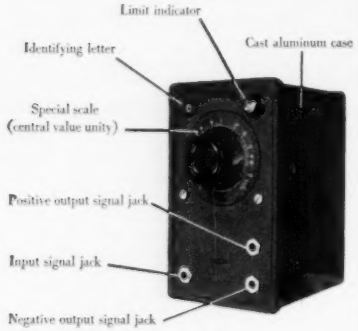
SPECIFICATIONS

Components: Regulated Power Supply, Central Chassis, Plug Panel, Rack and Accessories, 12 K3 Components (5 K3-C Coefficient Components, 3 K3-A Adding Components, 3 K3-J Integrating Components, 1 K3-L Unit-lag Component).
Excitation: Compound square-wave based on 0.004-second intervals. Connections provided for other forms of excitation.
Presentation: Recurrent solutions for all variables, via one or more oscilloscopes (not supplied), plotted against time or against one another.
Accuracy: Resolution for time and voltage 0.1%; Parametric Precision 1%.
Power Supply: 110v, 60 cycles, 500 watts.
Basic Computor Assembly, FOB Factory — $4200.00

Typical GAP/R Computor Component

Employed for the direct adjustment of local sensitivity in analog assemblies. Outputs are plus and minus the input signal multiplied by the numerical dial setting (0-100).

Model K3-C Coefficient Component



This component is one of a dozen similar types which are available from stock. Each performs a specific dynamic or mathematical operation, and is specially engineered to play its part most efficiently in any computing assemblage. Convenient to use, economical to buy, and of wide applicability, our GAP/R Analog Computor Components are now assisting study and development programs in many different fields. Is it not probable they can help you too?

Send your computing plans and problems to us for recommendations.

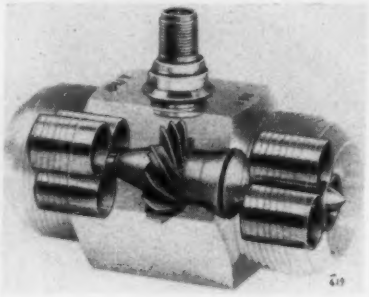
GEORGE A. PHILBRICK RESEARCHES, INC.
230 Congress St., Boston, Mass.

provided in any length from 5 to 200 ft. Housing is of aluminum alloy.—*Johnson Service Co., 507 E. Michigan St., Milwaukee 2, Wis.*

Mention No. 1107 when filling out card.

Flow-rate Transmitter

New flow-rate transmitter mounts directly in liquid line. A cylindrical permanent magnet within rotor sets up a rotating field which generates a.c. in pickup coil. Frequency equals rotor speed for two-pole magnet, is twice

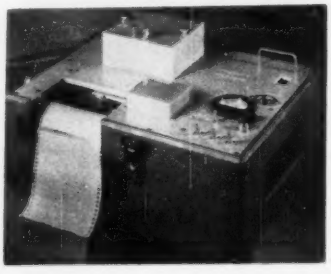


rotor speed for four-pole magnet. Generated a.c. is rectified for both rate indication, and integration of flow. Rotor "floats" in flowing fluid and needs no thrust bearings. Standard sizes range from 0.75 to 3.5 in. End connections above 1.5 in. size are flanged. Operating temperatures range to 1000 F, pressures to 20,000 psi.—*Potter Aeronautical Co., 87 Academy St., Newark, N. J.*

Mention No. 1108 when filling out card.

Frequency Response Recorder

New "Model FR" frequency response recorder has a separate motor to drive chart, with connections to auxiliaries, such as oscillator and analyser. Switch-



ing arrangement gives electrical remote control of signal source, in addition to mechanical link. New circuit gives wider frequency range to recorder, which records both alternating and direct voltages. Electronic circuit is integral part of instrument.—*Sound Apparatus Co., Stirling, N. J.*

Mention No. 1109 when filling out card.

Aneroid Barometer

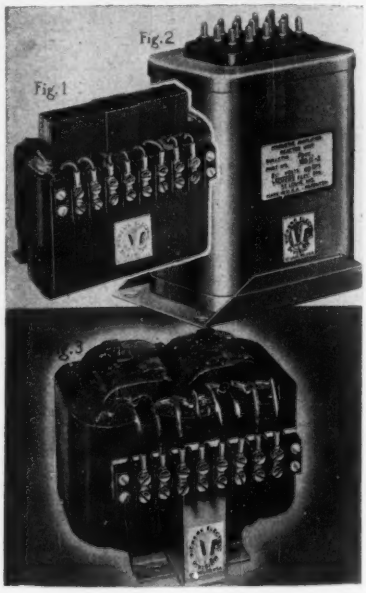
New "Type FA-160181" aneroid barometer has range of 26 to 31.5 in. Hg, or equivalent mm. of Hg., on 6 in. diam. dial. Atmospheric pressure deflects a capsule whose movement is

transmitted to pointer through a geared sector and pinion. A tension spring prevents backlash. Scales are individually calibrated. Sensitivity is 1 part in 500, and accuracy is 0.02 in. Hg. Weight 3 lbs.—*Wallace and Tiernan Products, Inc., Belleville 9, N. J.*

Mention No. 1110 when filling out card.

Magnetic Amplifiers

New line of magnetic amplifiers is available in three types. High-performance series (Fig. 1) are designed for 60 or 400 cps. power sources, and are supplied in 48 styles. Power output

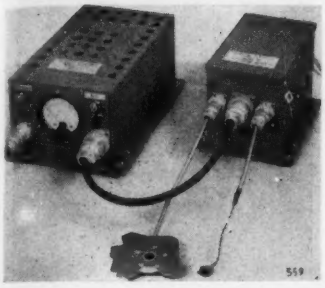


ranges from milliwatts to 385 watts. High-gain series (Fig. 2) operate on 60 cps, are available in 22 styles, with output power ranges from 0.5 to 1200 watts. High-power series (Fig. 3): 20 styles for 60-cps. applications, with power outputs from 65 to 3660 watts.—*Vickers Electric Division, 1815 Locust St., St. Louis 3, Mo.*

Mention No. 1111 when filling out card.

Dynamic Pressure-Measuring System

New pressure cells for dynamic measurement mount directly in surfaces upon which pressures impinge. Cells exhibit a uniform frequency response

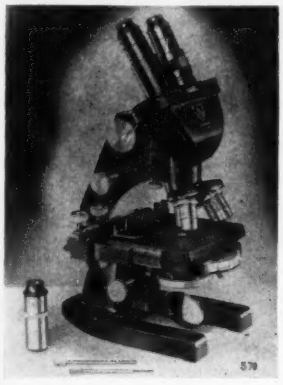


between 0 and 250 cps. Units are available with ranges of 0 to 2.5, 5, and 10 psi. Phase accuracy is better than 0.2 deg. Effects of accelerations are said to be negligible. Cell outputs can be combined electrically for measurements. Related equipment for driving standard oscillograph elements from cell output includes carrier-frequency bandpass amplifier, oscillator, and power supply. Two-channel amplifier dimensions 4.5 x 5.25 x 7.25 in.; weight 5.5 lbs. Oscillator-power supply is 6.25 x 4.75 x 11.25 in.; weight 10.75 lbs. Half-inch cells weigh less than 0.25 oz.—*Sierra Electronic Corp., 1113 County Road, San Carlos, Calif.*

Mention No. 1112 when filling out card.

Phase Microscopes

New phase microscopes have turret condensers with interchangeable annular diaphragms of hardened steel. Centerable mount is firmly held in fork-type substage, and diaphragms may be centered to any series of four objectives. Ball-bearing fine focusing adjustment

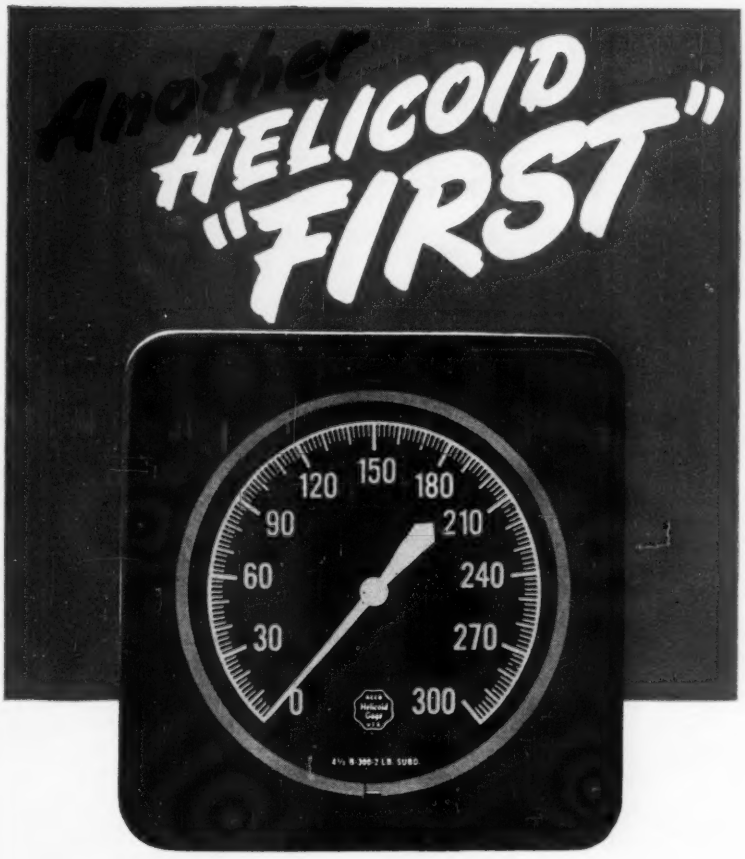


is graduated in two micron intervals. Tension on coarse and substage focusing controls is adjustable, and revolving nosepiece has ball-and-groove spring stop. Microscope has an aluminum arm and body. A separate accessory case accommodates phase turret condenser, objectives and centering telescope.—*American Optical Co., Southbridge, Mass.*

Mention No. 1113 when filling out card.

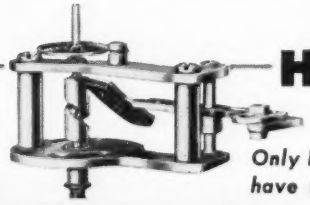
Metal Sorter

New "Metalsorter" identifies carbon and stainless steels, and non-ferrous alloys. Relative degree of heat-treatment or effect of cold reduction can be



NEW SQUARE, FLUSH CASE GAGE

- ideal for symmetrical panels
- saves space, improves appearance
- 4½", 6" and 8½" dial sizes
- all standard pressure ranges
- with or without internal illumination
- insist on HELICOID GAGES in the new square flush case for that next panel job



HELICOID

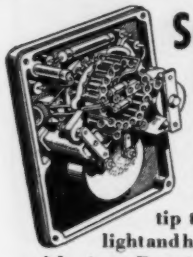
ACCO

Only Helicoid Pressure Gages have the Helicoid Movement

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
Bridgeport 2, Connecticut

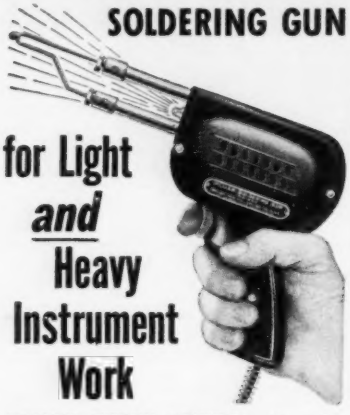
TRADE MARK

Adjust Heat INSTANTLY for ALL TYPES of Soldering



Controlled dual heat—on in 5 seconds, off when you release trigger—lets you adjust tip temperature for light and heavy instrument soldering. Precision balance, longer reach and tip construction ideal for delicate jobs. Rating up to 250 watts speeds heavy work. Time-and-power savings pay for your Weller Gun in a few months.

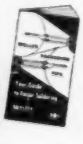
250-Watt WELLER SOLDERING GUN for Light *and* Heavy Instrument Work



- **TRIGGER-SWITCH CONTROL**—Ideal for intermittent work. No need to unplug gun between jobs.
- **5-SECOND HEATING**—No waiting, no wasted current.
- **PRECISION BALANCE**—Simplifies delicate work.
- **SOLDERLITE**—Spotlights the work.
- **LONGER REACH**—Slides easily into tight spots.
- **WELLERTIP**—Chisel shaped for faster heat transfer. Over/under terminals brace tip for heavy duty.
- **DUAL HEAT**—Single heat 200 watts; dual heat 200/250 watts; 120 volts, 60 cycles. For all instrument soldering.

See the 250-watt Weller Soldering Gun at your distributor, or write for bulletin direct.

SOLDERING GUIDE—Get your new copy of "Soldering Tips"—revised, up-to-date, fully illustrated 20-page booklet of practical soldering suggestions. Price 10c at your distributor, or order direct.



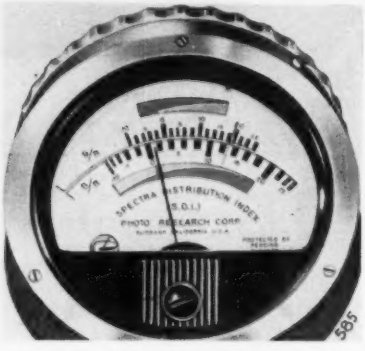
WELLER ELECTRIC CORP.
800 Packer Street, Easton, Pa.

determined. Basis for operation is electric current generated when dissimilar alloys move in frictional contact. Unknown alloy is compared with known test rod. Cabinet is isolated from vibration. Over-all dimensions 22.5 x 15 x 19 in.—*Doschek and Walker, 63 Crafton, Pa.*

Mention No. 1114 when filling out card.

Color-temperature Indicator

New "Spectra Three-color Meter" is latest model of "Spectra" line. For full description of original model see *Instruments*, Dec. 1948, p. 1121; of "Model B" see *Instruments*, Dec. 1949, p. 1116.) New model measures proportionate



amounts of all three primary colors, and expresses them in a new log unit known as "Spectra Index." For example, Index for photoflood lamps is 2.0/1.0. A photoflood lamp emitting light for which Type A color film is balanced should give a reading of 2.0 on blue-red scale and 1.0 on green-red scale. If reading is more than one unit high or low, a correction filter must be applied. A computer indicates directly filter to use.—*Photo Research Corp., 127-129 W. Alameda Ave., Burbank, Calif.*

Mention No. 1115 when filling out card.

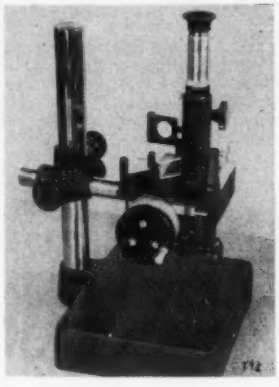
Bearing Temperature Control System

New bearing temperature control system consists of multiple mounting of maker's controlling pyrometers. A separate instrument and thermocouple are used for each bearing, and contacts can be high or low limit. Internal relays are rated 15 amp., 115 v., or 7.5 amp., 230 v. Transformer and rectified power supply for relays are mounted in cabinet, which is available in flush or surface mounting.—*Assembly Products, Inc., Chagrin Falls, Ohio.*

Mention No. 1116 when filling out card.

Michelson Interferometer

New "M30S" interferometer attachment is mounted on standard micrometer slide with either 25 mm, or 1 in. range. Micrometer drum is direct reading to 0.01 mm. or 0.0001 in. Settings can be made either by a microscope mounted in carriage or, for dial indicators, by contact with carriage. Measurements



are made either by counting interference fringes directly or by first using them to calibrate lead screw of micrometer slide and then using divided scale and drum on slide to obtain measurements. Magnification can be varied by use of interchangeable objectives. Standard eyepiece and cross hair reticle can be replaced with a filar eyepiece micrometer. A mercury lamp for interferometer work is also available. —*Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.*

Mention No. 1117 when filling out card.

Resetting Delay Timer

New "Type 5600" delay timer is powered by a Telechron motor, utilizing a tripping arm driven through a train of spur gears and a snap-acting s-p.d-t. switch. Resetting is instantaneous, accomplished by an electromagnetic coil which clutches and de-clutches a trip locking gear. Time period is adjusted by a screw. Switches are rated 10 amp. at 115 v. and 5 amp. at 230 v.

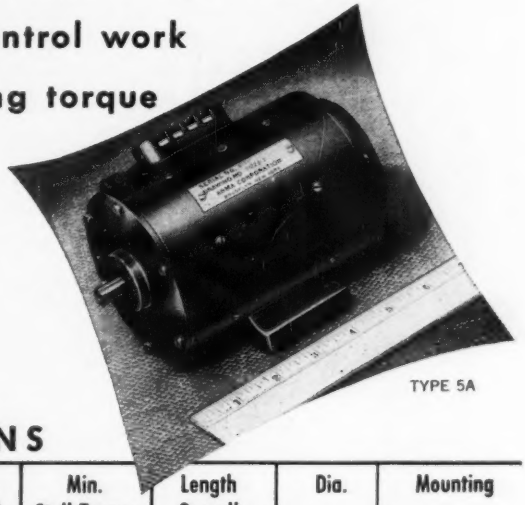
UNIVERSITY OF MICHIGAN LIBRARIES

Announcing 2

ARMA STEP MOTORS

. . . designed to replace a Synchro Unit and a servo motor in remote control work requiring torque

TYPE 3A



TYPE 5A

TYPICAL SPECIFICATIONS

	Dwg. No.	Voltage	Weight (Approx.)	Min. Stall Torque	Length Overall	Dia.	Mounting
Type 3A	715774-1	115 V d.c.	3 lb.	22 oz. in.	3-15/32"	3 in.	Flange
Type 5A	51224-1	115 V d.c.	10 lb.	55 oz. in.	6-11/16"	3⅝ in	Bracket type Base

FEATURES

• *Convenient mounting* • *Accurately ground, true running shaft extensions* • *Self-contained terminal blocks* • *Low power consumption* • *Conservative electrical design, low temperature rise, large creepage distances and air gaps*

COMPARED WITH ALTERNATING CURRENT SYNCHRO UNIT

- Much greater torque available than from same size A.C. Synchros.
- Both are used primarily for the transmission of data from one point to another. Both serve as remote indicators or repeaters.

Step Motor Booklet Just Printed Gives Complete Details
ASK FOR A COPY

ARMA CORPORATION
254 36th STREET, BROOKLYN 32, N. Y.
SUBSIDIARY OF AMERICAN BOSCH CORPORATION

ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

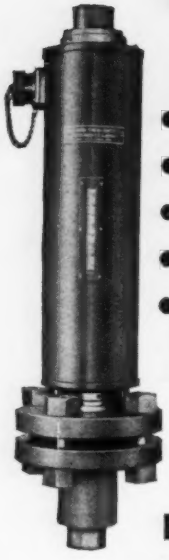
ARMA ELECTRICAL RESOLVERS* • ARMA SYNCHROS • ARMA INDUCTION MOTORS • ARMA INDUCTION GENERATORS • ARMA MECHANICAL DIFFERENTIALS • ARMA ALTERNATING VOLTAGE COMPARATOR • COMPUTING MECHANISMS • INDUSTRIAL CONTROLS • STABILIZATION DEVICES • NAVIGATIONAL EQUIPMENT • LIMITRON AUTOMATIC INSPECTION SYSTEM

* Licensed for use under Arma patents Nos. 2,465,624 and 2,467,646. License information available.

QUALITY ARMA INSTRUMENT PRECISION

CONTINUOUS PROCESS CONTROL

by Liquid Density



For use in

- BLENDING
- MIXING
- SEPARATION
- DILUTION
- CONCENTRATION OF INDUSTRIAL PROCESS LIQUIDS

PRINCO Densitrol

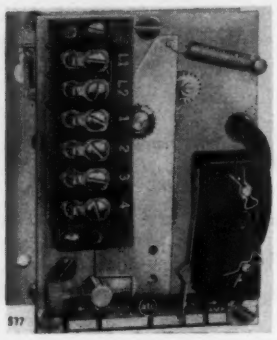
Trade-Mark ®

NEW PRINCO DENSITROL INDICATES, RECORDS, AND/OR CONTROLS LIQUID DENSITY. This rugged plant production tool has the sensitivity of a laboratory instrument, can be adapted to ranges as small as 0.005 density full scale.

Write for Bulletin W-10 or outline your requirements direct to

PRINCO

PRECISION THERMOMETER & INSTRUMENT CO.
1437 Brandywine St., Philadelphia 30, Pa.

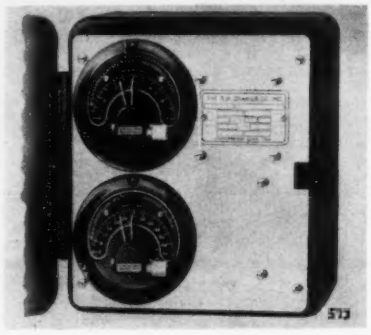


a.c. non-inductive load.—*Automatic Temperature Control Co., Inc., 5212 Pulaski Ave., Philadelphia 44, Pa.*

Mention No. 1118 when filling out card.

Duplex Cycle Timer

New "Type DU" duplex cycle timer will open and close one or two load or control circuits either continuously, or permit one complete cycle and then stop. Time ranges from 15 secs.-to 5 hrs. are available. One style for intermittent duty has a clutch built within motor and operated by a magnetic



effect on rotor. Second type for continuous duty has clutch consisting of two gear members actuated by a small electromagnet. Load contacts up to 15 amps., 115 v.a.c., are available.—*R. W. Cramer Co., Centerbrook, Conn.*

Mention No. 1119 when filling out card.

Crankcase Oil Tester

New "Model 75" measures light transmission through thin film of crankcase oil to indicate contamination; has internal voltage regulator; can be used on 105-125 v.a.c., or 6 v.d.c. Dry-disk type photocell connects directly to indicating instrument.—*Photovolt Corp., 95 Madison Ave., N. Y. 16, N. Y.*

Mention No. 1120 when filling out card.

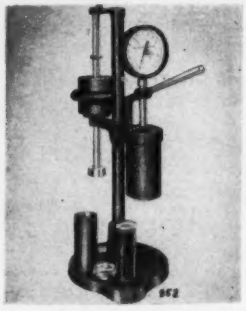
Portable Hardness Tester

New "Ernst" hardness tester is 3 x 2.5 in. diameter, and weighs 30 oz. Pressing hand-grips lowers indentor into material under constant load of 15.5 lb. Indentor movement is magnified by displacing liquid into a capillary which encircles scale. Liquid position on scale indicates hardness value. Scale can be calibrated in Rockwell, Brinell, Diamond Pyramid, or Tons Tensile.—*Distributed by Newage International, Inc., 521 Fifth Ave., N. Y., N. Y.*

Mention No. 1121 when filling out card.

Foundry Sands Tester

New "Gordon-Campbell" combination rammer-compression tester is designed for routine testing in foundry and laboratory of sand specimens. It conforms

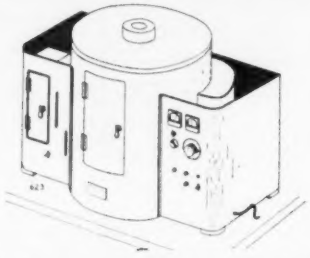


to recommendations of AFS Committee on Foundry Sand Research. For determination of compressive strength, pressure is gradually applied by hand until specimen collapses. Max. pressure in psi. is indicated by free pointer on gage.—*Claude S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.*

Mention No. 1122 when filling out card.

Aging-test Ozonator

New "GFB-LGL" ozonator for accelerated aging and weathering tests features uniform distribution of ozone and temperature. Air flow and adjust-



able generator voltage are indicated on panel instruments. Correction for ozone absorption efficiency, action of light, and effect of buffers' pH are not necessary.—*G. F. Bush Associates, Box 175, Princeton, N. J.*

Mention No. 1123 when filling out card.

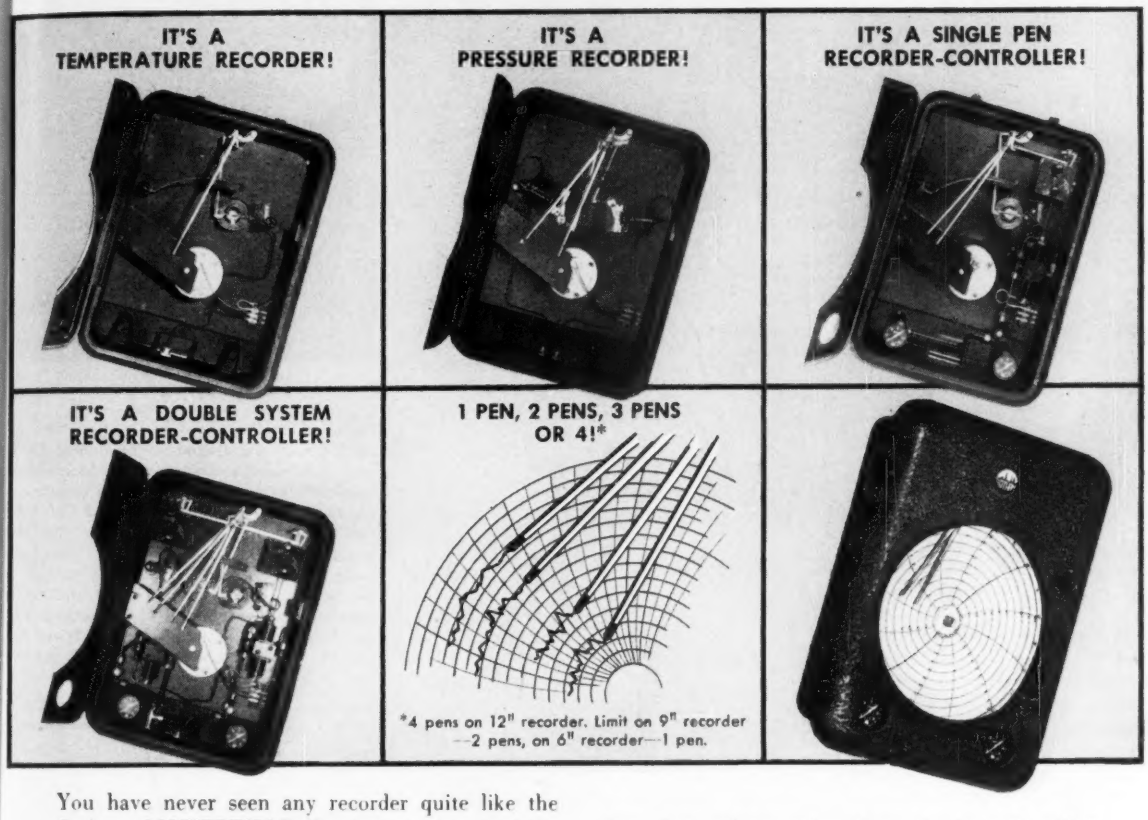
High-pressure Hose Tester

New "Model S-273" provides for pressure testing of hose up to 25,000 psi. Machine is self-contained and equipped with control valves, automatic quick release valve, automatic air bleed valves, filter, instruments, and two air operated, hydraulic boost pumps. One is for pressures to 1500 psi, second for pressures to 25,000 psi. A sump, 10 ft. long, with inclined drainboard, serves as testing chamber. Visibility and protection are provided by steel framed

UNIVERSITY OF MICHIGAN LIBRARIES

The GOTHAM CONVERTIBLE

A RECORDER YOU NEVER OUTGROW!


IT'S A TEMPERATURE RECORDER!
IT'S A PRESSURE RECORDER!
IT'S A SINGLE PEN RECORDER-CONTROLLER!
IT'S A DOUBLE SYSTEM RECORDER-CONTROLLER!
1 PEN, 2 PENS, 3 PENS OR 4!*
*4 pens on 12" recorder. Limit on 9" recorder —2 pens, on 6" recorder—1 pen.

You have never seen any recorder quite like the Gotham CONVERTIBLE. For here is one precision instrument that is as flexible as an eel. And a miser for maintenance. Read why!

The basic elements of the recorder, that is, the tube system, clock mechanism, and translating movement, are the same for 6", 9" and 12" chart size recorders. Temperature and pressure systems are completely interchangeable. Functions up to 4 pens can be added (to the 12" size) in a twinkling. Control through air relay or solenoid can also be easily added. For none of these changes, additions, or replacements, however, does any Gotham Convertible have to be returned to the factory.

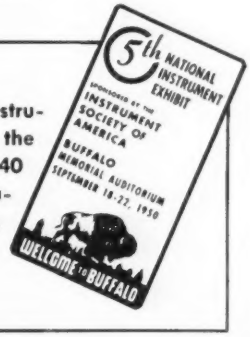
You yourself can change the instrument on the job in any way you desire to meet changing process requirements, without delay. Your maintenance inventory, because of interchangeability, is almost negligible. Write today for Bulletin.

Keep everything under control with Gotham

GOTHAM INSTRUMENTS

DIVISION OF
AMERICAN MACHINE AND METALS, INC.
149 Wooster St., New York 12, N. Y.

Don't fail to see this instrument and others in the Gotham line in booths 340 and 342 at the Instruments Show, Buffalo, New York — September 18-22, 1950.


5th NATIONAL INSTRUMENT EXHIBIT
SPONSORED BY THE INSTRUMENT SOCIETY OF AMERICA
BUFFALO MEMORIAL AUDITORIUM
SEPTEMBER 18-22, 1950
WELCOME TO BUFFALO

UNIVERSITY OF MICHIGAN LIBRARIES

Century

RECORDING GALVANOMETERS

The Century Model 210 Galvanometer has been designed and tested for the utmost in performance under any conditions. The unique small tubular type construction permits their installation in practically any type or make of photographic recording oscillographs. These galvanometers are offered at low cost over a wide range of frequencies and sensitivities to satisfy most recording requirements. For additional information, write for our Catalog No. CGC 206.

Manufactured under Century Pat. 2439576, also licensed by Kannestine Laboratories Patent 2149442.

Century

You are invited to visit our booth No. 118 during the 5th National Instrument Exhibit, Memorial Auditorium, Buffalo, N. Y., Sept. 18-22.

CENTURY GEOPHYSICAL CORPORATION

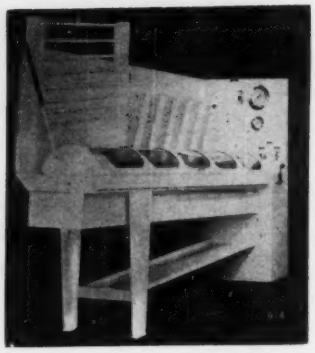
1340 North Utica

Tulsa, Oklahoma

EXPORT OFFICE: 149 Broadway, N. Y.

1505 Race Street Philadelphia

World's Largest Manufacturer of Geophysical and Special Galvanometers

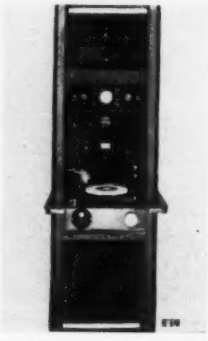


plexiglas cover which rolls away. A rack is furnished for draining hoses after testing.—*Sprague Engineering and Sales, 1144 W. 135th St., Gardena Calif.*

Mention No. 1124 when filling out card.

Sonic Comparator for Testing Abrasive Products

New sonic comparator, developed initially for rapid production testing of abrasive wheels, sticks, segments and tiles for grade, soundness and homogeneity measures natural period and amplitude of vibration of body under

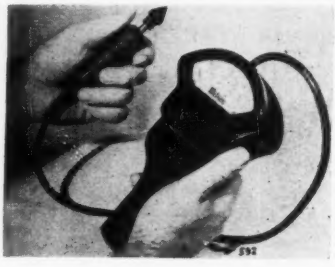


test, as related to period and amplitude for a standard body. Test requires from 10 to 15 sec. per article. Other applications include research or production testing of different types of ceramic, plastic and metallic bodies, because characteristics of vibration are uniquely sensitive to small physical differences. —*Saturn Electronic Co., 8237 Witkop Ave., Niagara Falls, N. Y.*

Mention No. 1125 when filling out card.

Electric Hand Tachometer

New "Type 25D" tachometer has ranges of 100-1000, 200-2000 and 500-5000 rpm and fpm, and 10-100, 20-200,



Precision Quality!

Immediate Shipment

GORDON THERMOCOUPLE EXTENSION LEAD WIRE

There are two good reasons why we stress Gordon Quality and Gordon Service. (1) The precision quality of Gordon Thermocouple Extension Lead Wire is based upon 36 years of experience in careful selection and inspection to meet rigid insulation requirements. (2) Gordon's Chicago and Cleveland plants carry complete stocks of Thermocouple Extension Lead Wire for practically every application. (See illustrations below.) This means that your order gets immediate delivery of a QUALITY product—one that meets Bureau of Standards Specifications. ORDER NOW! No waiting or delay. Prices available upon request.

CHROMEL-ALUMEL, Cat. No. 1231(3-A), 14 ga., STRANDED-DUPLEX, each wire felted asbestos, Asbestos-yarn braid overall.

FOR PLATINUM THERMOCOUPLES, Cat. No. 1225, 16 ga., STRANDED-DUPLEX, each wire felted asbestos, Asbestos-yarn braid overall.

CHROMEL-ALUMEL, Cat. No. 1234, 14 ga., SOLID-DUPLEX, each wire enamel, felted asbestos, Asbestos-yarn braid overall.

IRON-CONSTANTAN, Cat. No. 1236-C, 14 ga., STRANDED-DUPLEX, each wire felted asbestos, Asbestos-yarn braid overall.

COPPER-CONSTANTAN, Cat. No. 1235-A, 14 ga., SOLID-DUPLEX, each wire cotton, rubber, weatherproof braid, lead sheath overall.

GORDON SERVICE

CLAUD S. GORDON CO.

Specialists for 36 Years in the Heat Treating and Temperature Control Field

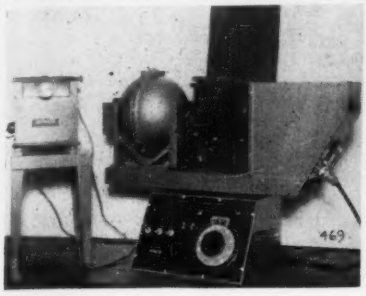
Dept. 21 3000 S. Wallace St., Chicago 16, Ill.
Dept. 21 2035 Hamilton Ave., Cleveland 14, O.

50-500 fpm. Range-extending adapters are available to measure speeds from 20 rpm to 50,000 rpm.—*Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.*

Mention No. 1126 when filling out card.

Hazemeter for Plastics, etc.

New "Hunter" pivotable-sphere hazemeter is designed for measurement of haze and luminous transmittance of transparent plastics and other materials according to ASTM Method D1003-

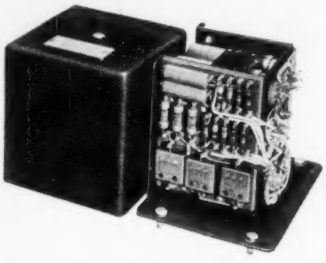


49T. Instrument has advantage over fixed-sphere method of no large galvanometer deflections, no diffuse-reflectance errors, and no change in integrating characteristic of sphere with change of surface.—*Henry A. Gardner Lab., Inc., 4723 Elm St., Bethesda 14, Md.*

Mention No. 1127 when filling out card.

Servo Amplifier

New servo amplifier enables servo designers to have a complete servo loop, meeting requirements of system under study, in a time claimed to be "a fraction of time previously necessary to build these circuits." Amplifier is de-



signed to drive a control motor wound for plate-to-plate operation. It operates with a variety of a-c. transmission elements such as autosyns and both resistive and inductive tapped rheostats. In carrier-frequency loops, it provides circuitry needed in error-signal path.—*Transicoil Corp., 107 Grand St., New York 13, N. Y.*

Mention No. 1128 when filling out card.

Speed Controller for Electric Motors

New device presets speed of a-c. brush-shifting motor, by a knob mounted on motor, or on flexible cable up to 15 ft. away. Speed is adjustable at standstill or while running. Mechanism actuates a pilot motor which drives

Century MODEL 406

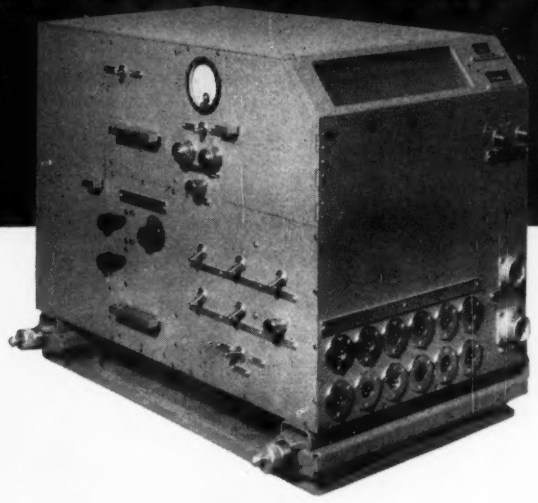
RECORDING OSCILLOGRAPH

FOR

VIBRATION — TEMPERATURE

STRESS — STRAIN ANALYSIS

where any or all of the above information is an important factor.



FEATURES

1. 12—50 individual channel recording.
2. Continuous recording up to 200' without jamming
3. Instantaneous changes of recording speeds up to 50" per second with automatic adjustment of lamp intensity.
4. Timing System — Discharge lamp controlled by temperature compensated tuning fork providing sharp .01 second with heavier .1 second timing lines. Conversion to .1 second lines only, by switching.
5. Independent optical system provides constant view of traces with optimum light intensity at all times.
6. Recording lamp under constant surveillance of external condition indicator lamps.
7. Galvanometers — with optional range of frequencies and sensitivities.
8. Electrical — Available for operation from option of 12 or 24 volts D.C., or 110 volts A.C.

OPTIONAL FEATURES

1. Trace identification by means of light interruption.
2. Trace scanning for observation of steady state phenomena.
3. Remote control unit.
4. Automatic record numbering system.
5. Automatic record length control.
6. Visual paper footage indicator.

You are invited to visit our booth No. 118 during the 5th National Instrument Exhibit, Memorial Auditorium, Buffalo, N. Y., Sept. 18-22.

For additional information write 1340 North Utica

Century GEOPHYSICAL CORPORATION

TULSA, OKLAHOMA

1505 Race Street
Philadelphia, Pa.

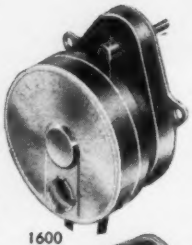
EXPORT OFFICE:
149 Broadway, New York

Timing Ideas

WHEN TIMING COUNTS

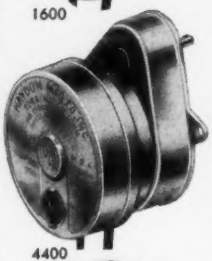
You can always count on Haydon to provide the right motor for your timing job. Timing Headquarters offers a broad line of efficient, economical timing motors and timers produced by specialists who have no other interest than to provide the best in timing.

LOW COST VERSATILITY—1600 SERIES: Specifically designed as a standard component for the widest possible range of timing applications with 79 speeds from 300 rpm to 1 revolution per 4 hours.



1600

COMPACTNESS AND SLOW SPEED—4400 SERIES: Designed for small size and low cost in applications requiring slower speeds from 6 hours to 7 days per revolution.



4400

HEAVY DUTY DEPENDABILITY—3100 SERIES: For control and instrument applications that require a heavy duty train and speeds from 1 hour to 14 days per revolution.

SUPERIORITY FEATURES Slow (450 rpm) rotor speed makes for quiet operation and long life. Unusually small. All motors totally enclosed. Separate rotor and reduction gearing lubricating systems permit selection of best methods and lubricants, control circulation, insure against leakage. Operates continuously in any position. Simple to mount, entire face of motor can be supported securely against mounting surface. Standard, interchangeable design in only 2 motor series with speed range from 300 rpm to 1 revolution in 7 days.

3100

For complete design and engineering specifications, write for catalog: Timing Motors No. 322 — Timers No. 323 — Clock Movements No. 324. Yours without obligation.

HAYDON AT TORRINGTON

HEADQUARTERS FOR TIMING

HAYDON Manufacturing Co., Inc.

2033 ELM STREET

TORRINGTON, CONNECTICUT

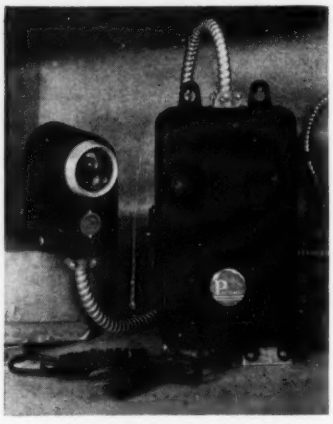
SUBSIDIARY OF **GENERAL TIME** CORPORATION

brushes to position set by adjusting knob. On stopping, brushes return to lowest speed position, but come back to present speed when motor is restarted.—*General Electric Co., Schenectady, 5, N. Y.*

Mention No. 1129 when filling out card.

Photoelectric Counting Equipment

New "Set P2C" has an operating range up to 10 ft. between photoelectric unit and light source. Both must

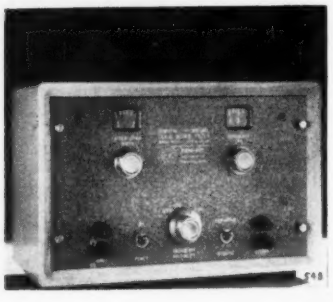


be rigidly mounted to maintain light beam alignment. Unit makes up to 600 counts per minute.—*Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.*

Mention No. 1130 when filling out card.

Control-function Analog Component

New "Model 340-A Derivative-integral Servo-design Filter" is designed to assist determination of optimum filter



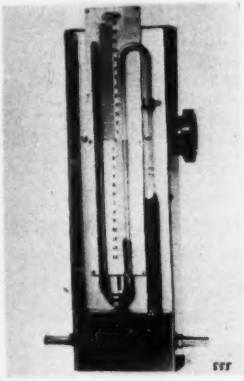
UNIVERSITY OF MICHIGAN LIBRARIES

characteristics for feedback-control systems. When used in d-c. path of a servo loop, unit represents a compensating function which approximates either proportional plus derivative, or proportional plus integral correction. Function is ratio of two first-order polynomials. Filter may be adjusted for operation in range 0.01 to 100 cps., with attentuation ratios from 2 to 50.—*Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass.*

Mention No. 1131 when filling out card.

Protected-glass Manometer

New manometer is made entirely of metal with exception of U tube which is protected and easily interchangeable.



Dust-filter trap keeps mercury clean, and balance-type chain drive permits rapid scale adjustment. Ground-metal on-off stopcock is impervious to mercury vapors.—*E. Machlett & Son, 220 E. 23rd St., New York 10, N. Y.*

Mention No. 1132 when filling out card.

Photoelectric Colorimeter

New "Model 401" has internal voltage regulator, and can be used on 105-125 v.a.c., or 6 v.d.c. Tube sizes of 14, 18, and 22 mm. OD, and rectangular cuvettes, can be used. Tubes mount in sliding carrier, and photocell is molded in plastic. Glass color filters provide narrow spectral bands. Instrument case has clear plastic cover.—*Photovolt Corporation, 95 Madison Ave., N. Y. 16, N. Y.*

Mention No. 1133 when filling out card.

Eight-ohm L-pad

New "Type No. CM8727," 8 ohm L-Pad is a single unit with two separate wire windings for maintaining constant impedance. Size is 1.25 diam. by 0.562 in. deep. Available within impedance ranges from 6 to 300 ohms. Rotation of control is 120 deg.—*Clarostat Mfg. Co., Inc., Dover, N. H.*

Mention No. 1134 when filling out card.

Photoelectric Smoke Indicator

New smoke indicator has operating range up to 20 ft. between light source and photoelectric scanner mounted on opposite sides of stack. Control box

BIDDLE

NUMBER 2 OF A SERIES

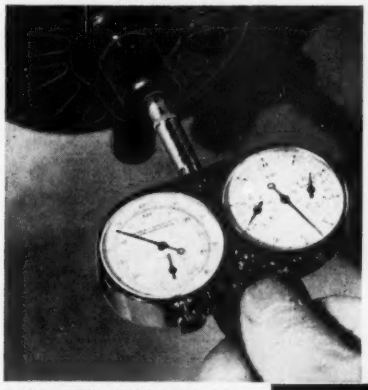
Instrument News

JAMES G. BIDDLE CO., 1316 ARCH ST.
PHILADELPHIA 7, PA.

ELECTRICAL TESTING • SPEED MEASURING INSTRUMENTS • LABORATORY & SCIENTIFIC EQUIPMENT

UNIQUE INSTRUMENT INTEGRATES SPEED AND TIME
Eliminates "Human Element" of Error

The Tachoscope is rather remarkable for what it will do in the measurement of speed. It is a speed-counter and stop watch combined in such a way as to eliminate the usual error in starting and stopping. The simple pressing of a lever starts the watch and counter at the same instant. After a suitable time—say 30 seconds to a minute or more—press the same lever to stop both mechanisms. Divide the indicated number of revolutions by the elapsed time (in minutes) and the answer is the average rpm for the time of the test. The instrument is not intended to indicate rpm or fpm directly, as do indicating hand tachometers and speed indicators.

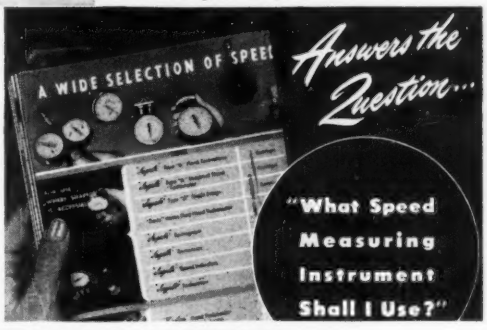


The elimination of error at starting and stopping plus the length of time it may be operated, make the Tachoscope a high precision instrument. Many use it as a standard for other speed measuring instruments. Naturally, the longer operating time results in higher accuracy of the calculated result.

The Tachoscope can be used on many types of machines for speeds up to 20,000 rpm. The high-grade stop watch can be used independently.

SEND FOR BULLETIN 35-I
Includes Handy Selection Chart
Thousands of copies of this helpful and interesting bulletin on Speed Measuring Instruments have been requested since its publication. Did you get your copy?

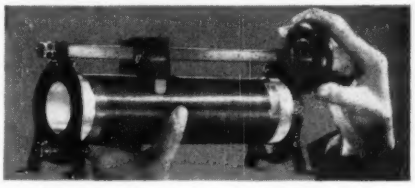
VISIT THE BIDDLE BOOTH AT BUFFALO ISA SHOW
Location No. 239 will feature a new Biddle Co. exhibit with new instruments. Biddle engineers will be in attendance to answer your questions. Come in and say hello!



"JAGABI"® LUBRI-TACT POWER RHEOSTATS
Standard Types in 76 Different Ratings

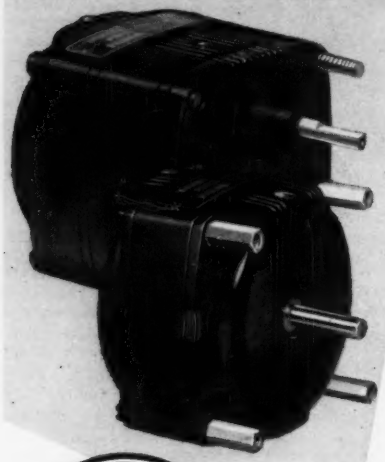
For fine adjustment and control of electrical current—from "zero" to as high as 25 and 50 amperes. Engineers and laboratory workers find "Jagabi" Rheostats have many superior refinements, including the Lubri-tact, graphited carbon lubricator brush which slides with a phosphor bronze current-carrying brush—no scratching or sticking on the resistance winding even at high temperatures. Solid wall porcelain tubes assembled by expert workmanship, with precise adjustment and control, combine to make "Jagabi" a sturdy long lasting construction.

Among the many varieties manufactured by James G. Biddle Co. craftsmen are screw drive rheostats, double rheostats with one or two sliders, water cooled rheostats, graded rheostats up to 24" long with different sizes of resistance wire, switchboard rheostats, rheostats in metal cages, and non-inductive rheostats.



Bulletin 41-I is a thorough description of "Jagabi" Lubri-tact, as well as "Jagabi" Compression Carbon Rheostats for controlling heavy current . . . also "Jagabi" Resistance Units. Your request will bring this booklet by return mail.

RELIABLE PRECISION-MADE MOTORS



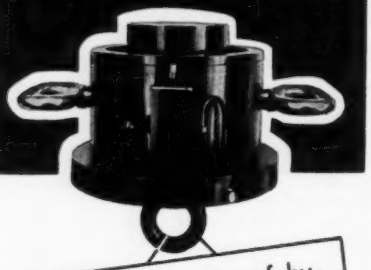
for Quality Instruments

Wherever instruments require reliable power, Bodine fractional horsepower motors should be specified. Bodine Type K motors, with or without built-in speed reducer, are especially designed for use on instruments and control apparatus. Normal 60-cycle output ranges from 1/2000 hp to 1/500 hp. Write for information. Bodine Electric Company, 2244 W. Ohio St., Chicago 12, Illinois.

BODINE

FRACTIONAL HORSEPOWER MOTORS

now you can assemble your own



Force Measuring systems

for use in applications such as dynamometers, industrial weighing, strength of structures, jet engine thrust, and countless other force-measuring problems. Illustrated is the famous Emery Hydraulic Cell, basic unit of Emery hydraulic testing and force-measuring systems.

All components are simply constructed, but rugged; they are compact in size, extremely sensitive and accurate. Easy to mount and use. Send for complete literature and prices; also our engineers will be pleased to discuss your force-measurement problems and make recommendations.

a complete line of hydraulic components: load cells for compression and tension; load indicators; strip and circular chart recorders; hydraulic jacks, valves, tools, and other special devices.

THE A.H.EMERY CO. · THE A.H.EMERY CO. · 75 YEARS · HYDRAULIC WEIGHING

STAMFORD, CONN.

houses indicating instrument, red and green warning lights, and adjustable alarm. Unit operates on 115-230 v.—*Combustion Control Corp., 77 Broadway, Cambridge 42, Mass.*

Mention No. 1135 when filling out card.

Ground Resistance Tester

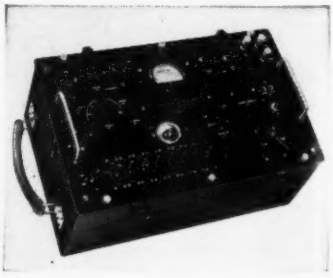
New "Type CVM Megger" measures resistance to earth of man-made grounds. Two switches are provided which short-circuit terminals for 2, 3,

and 4 terminal tests. Instrument has two scales, and available ranges are 0 to 40 and 200 ohms, and 0 to 100 and 500 ohms.—*James G. Biddle Co., Phila., Pa.*

Mention No. 1136 when filling out card.

Multi-purpose Transmission Test Set

New "693" multi-purpose transmission test set may be used for efficiency tests on local and common battery telephone lines and sets, microphones, etc.,



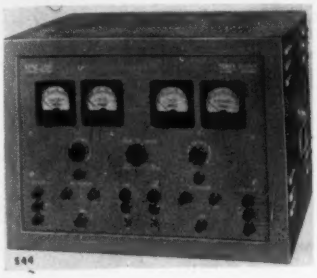
UNIVERSITY OF MICHIGAN LIBRARIES

and to test capacitors, generators, ringers, insulation resistance, dials, and continuity. Key switches and dials are used to select and control test circuits. Set is powered by external batteries.—*Shallcross Mfg. Co., Collingdale, Pa.*

Mention No. 1137 when filling out card.

Duplex Regulated Power Supply

New "Model 510" voltage-regulated power supply features two independent d-c output voltages, continuously variable from 200 to 500 at 0 to 200 ma. Variation is less than 0.5 percent for



both line fluctuation from 105 to 125 v. and load variation from min. to max. current. Ripple is less than 5 mv. Each a-c. output is 6.3 v., 6 amp., c-t., unregulated. Power requirement: 600 watts. Outputs may be used separately, in parallel, in series, and bucking.—*Kepco Labs., Inc., 149-14 41st. Ave., Flushing, N. Y.*

Mention No. 1138 when filling out card.

Sweep Generator

New "Models RFP and RFB" all-electronic sweep and marker generator are suitable for alignment of TV tuners and complete receivers. A 12-position channel switch selects narrow pip-type crystal positioned picture and sound

carrier markers, as well as 15 Mc. wide sweep oscillator circuit. All carriers are oscillator fundamentals. Instrument also produces zero-amplitude reference baseline on oscilloscope display. Markers are fed direct to indicator scope. Sweep outputs are from maxima of 0.5 v. for 70-ohm balanced output and 10. v. for 300-ohm balanced output down to maxima suitable for aligning sensitive receivers. A regulated power supply is used.—*Kay Electric Co., Maple Ave., Pine Brook, N. J.*

Mention No. 1139 when filling out card.

Sweep Generator

New "Switcha-Sweep" TV sweep generator with fundamental outputs on all channels as well as output in IF range has a rotary switch to select de-

Elapsed time intervals can be measured down to 1/1000th second with a

STANDARD PRECISION TIMER

The world's most accurate (and rugged) time measuring instrument. Available in 8 models as shown below:

MODEL	READS	TOTALIZES	ACCURACY
S-100	1/5 sec.	6000 sec.	± .1 sec.
S-60	1/5 sec.	60 min.	± .1 sec.
SM-60	1/100 min.	60 min.	± .002 min.
S-10	1/10 sec.	1000 sec.	± .02 sec.
S-6	1/1000 min.	10 min.	± .0002 min.
S-1	1/100 sec.	60 sec.	± .01 sec.
MST	1/1000 sec.	.360 sec.	± .001 sec.
MST-500	1/1000 sec.	30 sec.	± .002 sec.

Manually and Electrically Operated Portable Cases or Panel Mounting optional changes to conform to customers' requirements.

Special Timing Problem. **Our engineers are ready to consult with you, and design timers to meet special timing problems.**

OTHER PRODUCTS

Standard Chrono-Tachometers, Custom-built Laboratory Test and Distribution Panels, School Time Program Systems, Hospital Doctor Paging and Nurse Call Systems.

WRITE FOR BULLETIN NO. 153

STANDARD

THE STANDARD ELECTRIC TIME CO.

RELAYS and TIME SWITCHES
of Diamond AEMCO Quality

Open Type
"Can" Type
With Plug-in
Tube Base
A. C. or D. C.
Midget Relays
Dual Purpose
Relays
Delayed
"Make" or "Break"
Automatic
Circuit Control
"Current" and
"Potential" Relays

Ruggedly constructed to exacting specifications that are carefully engineered to provide ample safety factor . . . quality all the way through!

Automatic's relays are not built to a price but to an unexcelled standard of performance. That's why they are the choice of so many "big name" manufacturers.

We engineer and build a wide variety of stock model relays for practically all applications. A staff of competent engineers will design and build relays to fit *your* requirements.

Stock models or custom built, every relay we manufacture will deliver the same dependable performance that has made the "Diamond Seal" line the choice of those who measure *quality* by *performance*.

- **TIME SWITCHES—Equipped with Synchronous Self-Starting Motors and Silver Contacts.**

For any load, for every installation, look to Automatic for the finest in Time Switches and Interval Timers.

WRITE FOR CATALOG

AEMCO

Automatic Electric MFG. CO.

58 STATE STREET · MANKATO, MINN.

when you need resistors—

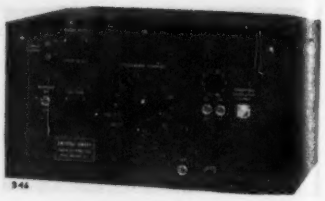
IT WILL PAY YOU TO CONSULT THE NEW

IN·RES·CO CATALOG

Included are complete descriptions and specifications on wire wound resistors of all types and sizes. Each is precision wound to close tolerance, and many feature special moisture-proofing to assure proper functioning under severest climatic conditions. INRESCO Resistors —available for IMMEDIATE DELIVERY—are supplied in standard or custom types to meet the most unusual design or operational requirements, and are offered at prices that benefit from mass production facilities. A copy of the new INRESCO catalog will be helpful; write for it today. Prices, samples and estimates promptly on other than standard resistors.

INSTRUMENT RESISTORS COMPANY
1036 COMMERCE AVE., UNION, N. J.

Wire Wound Resistors for Every Use in Electronics and Instrumentation

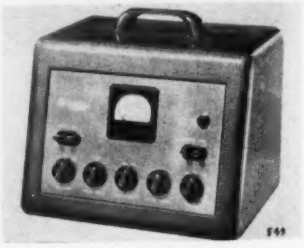


sired channel, which is swept through a range of 15 Mc. AM of sweep signal is less than 1 percent per Mc. Max. outputs are about 0.5 v. on 70-ohm unbalanced and 1.0 v. on 300-ohm balanced output.—*Kay Electric Co., Maple Ave., Pine Brook, N. J.*

Mention No. 1140 when filling out card.

Pulse Generator

New "Model 1022" pulse generator provides pulses, positive or negative, with a choice of 1, 10, or 100 microseconds width. Max. amplitude is 20 v., in ranges of 0-0.5, 0-5, and 0-20 v.

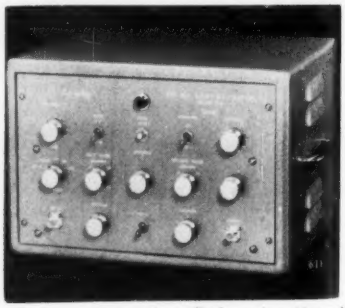


full scale. Variations in line voltage between 110-125 do not affect output. On 60 cps. supply pulse frequency is 60; with external oscillator it may vary between 10 and 200,000 per sec. Accuracy is 5 percent over entire range. —*Nuclear Instrument & Chemical Corp., 229 W. Erie St., Chicago 10, Ill.*

Mention No. 1141 when filling out card.

Double-pulse Generator

New "Model 902" double-pulse generator produces two pulses whose amplitude is individually adjustable, without cross effect, from 0 to 50 and 0 to −200 volts. Amplitude of both pulses after mixing can be varied by means of a continuous fine control plus a 10



to 1 step attenuator. Pulse rise time is 0.05 microseconds, decay time 0.10 microseconds. Duration is individually adjustable from 0.15 to 1.5 microseconds. Spacing between two pulses is continuously variable in two ranges, −0.5 to +3 microseconds. Repetition rate is adjustable in 3 ranges: 1 to 10

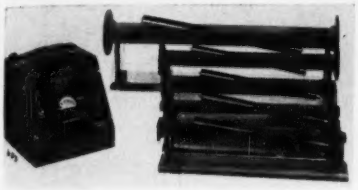
UNIVERSITY OF MICHIGAN LIBRARIES

10 to 100, and 100 to 1000 cps, and can be externally triggered. Output impedance is approximately 400 ohms; maximum output voltage is –200 v. Overall accuracy of control calibrations is 5 percent over entire range.—*Berkeley Scientific Company, 6th and Nevin Sts., Richmond, Calif.*

Mention No. 1142 when filling out card.

Random-noise Generators

New "Microwave Mega-Nodes," are random noise generators designed to produce a known output in frequency range of 2600 to 12,400 Mc. They are a group of five noise sources, each utilizing a standard commercial flourescent

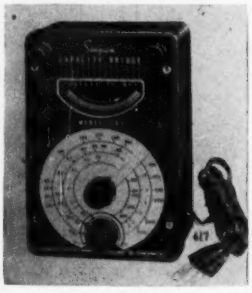


lamp in a JAN size waveguide, each mounted on a hardwood stand. A separate cabinet houses power supply for noise sources. Plug-in cables are provided for direct connection of power supply to any one microwave unit. Over operating range, the VSWR of each generator is less than 1.1, with exception of one guide whose VSWR goes to 1.19 over about 20 percent of frequency range. Noise output of each generator is 15.84 db above thermal noise at a waveguide temperature of 32 C.—*Kay Electric Co., Maple Ave., Pine Brook, N. J.*

Mention No. 1143 when filling out card.

Capacitance Bridge

New "Model 381" measures 3.625 x 5.5 x 2.375 in. Weight tester is 1.75 lbs. Unit has three capacity ranges—20



to 500 uuf, 0.005 to 2 uf and 1 to 500 uf. Panel is made of etched aluminum, and case is molded plastic.—*Simpson Electric Co., Chicago, Ill.*

Mention No. 1144 when filling out card.

Impedance Bridge

New "Model 250-B" has ranges of 1 milliohm to 11 megohms resistance, 1 uuf to 1100 uf capacitance, 1 microhenry to 1100 henrys inductance, 0.001 to 1.0 dissipation factor and 0.02 to 1000 storage factor. Accuracy in LRC

Whatever your requirements for control boards, electrical housings or enclosures, KIRK & BLUM is equipped and experienced to fabricate them to the most exacting specifications . . . one unit or hundreds. We specialize in custom-built parts and assemblies of sheet steel, light plate, stainless, aluminum, monel and other alloys in gauges 3/8" and lighter.

For more detailed information, write now for your free copy of The NEW KIRK & BLUM Electrical Enclosures Booklet . . . completely illustrated. For prompt quotation, send prints to THE KIRK & BLUM MFG. CO., 2911 Spring Grove Ave., Cincinnati 25, Ohio.

- Control Desks • Cubicles • Electrical Cabinets & Enclosures
- Power Distribution & Control Panels • Switch Gear Housings
- Boiler, Generator & Turbine Control Panels • Louvres
- Test Stands, Controls & Desks • Instrument Panels
- Outdoor Electrical Enclosures
- Transformer Tanks

. . . and other Fabricated Products

KIRK AND BLUM

The new S.S.WHITE 80X HIGH VOLTAGE RESISTOR

(½ Actual Size)

4 watts • 100 to 100,000 megohms

Developed for use as potential dividers in high voltage electrostatic generators, S.S.White 80X Resistors have many characteristics—particularly negative temperature and voltage coefficients—which make them suitable for other high voltage applications.

They are constructed of a mixture of conducting material and binder made by a process which assures adequate mechanical strength and durability. This material is non-hygroscopic and, therefore, moisture-resistant. The resistors are also coated with General Electric Dri-film which further protects them against humidity and also stabilizes the resistors.

WRITE FOR BULLETIN 4906

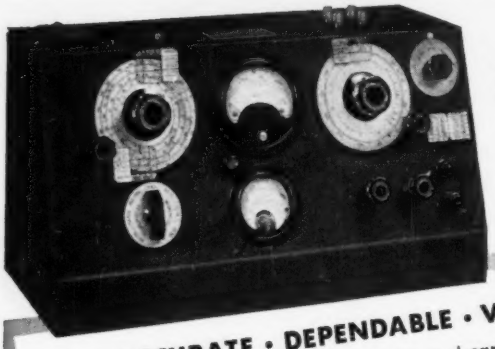
It gives complete information on S.S.White resistors. A free copy and price list will be sent on request.

S.S.WHITE INDUSTRIAL DIVISION

THE S. S. WHITE DENTAL MFG. CO. — DEPT. 1 — 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS AND ACCESSORIES
MOLDED PLASTICS PRODUCTS—MOLDED RESISTORS

One of America's AAAA Industrial Enterprises



The Q METER

TYPE 160-A

ACCURATE • DEPENDABLE • VERSATILE

For the measurement of Q, inductance, and capacitance, the 160-A Q-Meter is the universal choice of radio and electronics engineers. Its wide frequency coverage from 50 kc. to 75 mc. is an outstanding feature which makes possible the accurate and rapid evaluation of components and insulating materials at the actual operating frequency.

SPECIFICATIONS

OSCILLATOR FREQUENCY RANGE: 50 kc. to 75 mc. 8 self contained ranges.

OSCILLATOR FREQUENCY ACCURACY: ±1%, 50 kc.-50 mc. ±3%, 50 mc.-75 mc.

Q-MEASUREMENT RANGE: Directly calibrated in Q, 20-250. "Multiply-Q-By" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q-range to 625.

Q-MEASUREMENT ACCURACY: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.

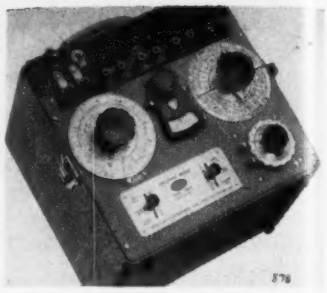
CAPACITANCE CALIBRATION RANGE: Main capacitor section 30-450 mmf, accuracy 1% or 1 mmf. whichever is greater. Vernier capacitor section +3 mmf., zero, -3 mmf. calibrated in 0.1 mmf. steps.

Accuracy ±0.1 mmf.

Write for literature containing further details

BOONTON RADIO Corporation

BOONTON-N-J-U-S-A



measurements is 1 percent or better. Main dial is 4 ft. long. Readings are independent of frequency up to 10 kc. A 1000-cps. microphone hummer is used as internal bridge generator. Four flashlight cells supply power. Instrument is 8.75 x 10.5 x 10.5 in., and weighs 15 lbs.—*Brown Electro-Measurement Corp., Dep't.* I-2, 4635 *S.E. Hawthorne Blvd., Portland* 15, *Ore.*

Mention No. 1145 when filling out card.

Bridge Amplifier

New "Model 850-B" amplifier is battery operated. Gain is continuously adjustable to 52 db. Low microphonic sub-miniature tubes are used. Response is down 20 db at 2000 cps. In off position, switch transfers input to output terminals. Over-all dimensions 6 x 2.5 x 1.5 in. Weight is 1 lb.—*Brown Electro-Measurement Corp., Dep't.* I-2, 4635 *S.E. Hawthorne Blvd., Portland* 15, *Ore.*

Mention No. 1146 when filling out card.

Power-frequency Amplifier for Instruments

New "Model 105" amplifier is used to measure voltage or power, drawing 150 microamperes maximum from circuit under test. Instrument has 150 v.

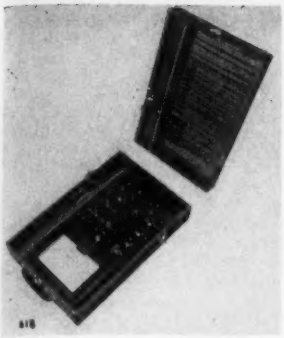
output for inputs from 15 to 600 v., and supplies up to 70 ma. for output voltmeter or wattmeter. Gain is constant from 5 to 20,000 cps., with no response to d.c. at input. Power supply is 200 watts at 105-125 v., 50-60 cps. Cabinet is 10 x 17 x 3 in.—*Keithley Instruments,* 1507 *Warrensville Center Road, Cleveland,* 21, *Ohio.*

Mention No. 1147 when filling out card.

Deflection Potentiometer for TC Measurements

New "Model 150" indicating potentiometer has 6 in. scales graduated 0 to 22 mv., 0 to 2500 F, chromel-alumel, and –150 to 700 F, copper-constantan.

UNIVERSITY OF MICHIGAN LIBRARIES

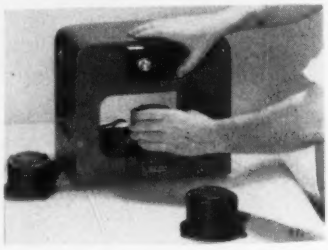


Readings are taken by null method, then indicated continuously after adjusting for couple resistance. Instrument is compensated for case temperature of 70 to 90 F. Case is 13.5 x 20.5 x 6 in., weight 20 lb.—*Kirby Walker, 7221 West Madison, Forest Park, Ill.*

Mention No. 1148 when filling out card.

Demagnetizer

New demagnetizer consists of an air-core coil built in a frame for mounting on table or bench. Coil is rated at 115 v., 60 cps, and is equipped with switch,



pilot lamp, and flexible lead fitted with standard plug. It has a rectangular opening 4.5 x 8.5 in. to accommodate stock up to 8 in. wide.—*Special Products Div., General Electric Co., Schenectady 5, N. Y.*

Mention No. 1149 when filling out card.

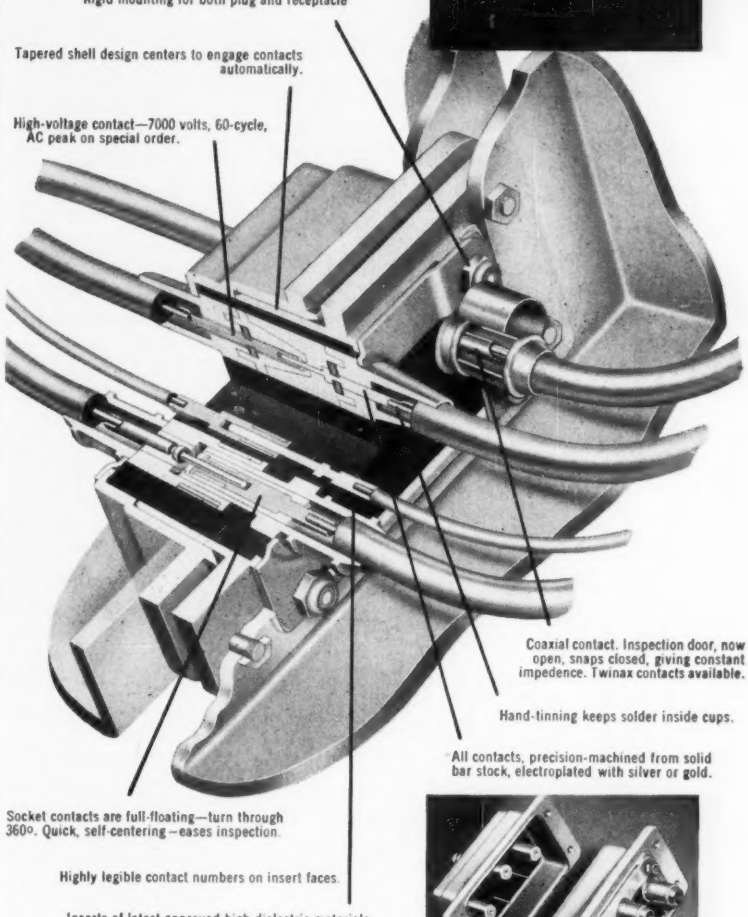
RF Wattmeter

New power level meter employs a diode under temperature limited conditions. With a feedback loop, this produces a power indication on a linear scale. Standard portable instrument has full-scale ranges of 1 mw, 10 mw, 100 mw, 1 watt, and 10 watts, into 600 ohms. Instrument is accurate within 2%

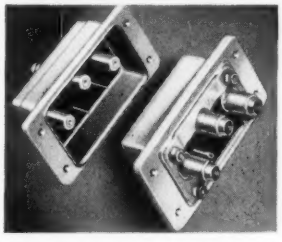
Here's why those in the know

—demand

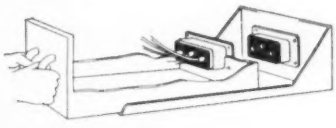
CANNON PLUGS


Rigid mounting for both plug and receptacle
Tapered shell design centers to engage contacts automatically.
High-voltage contact—7000 volts, 60-cycle, AC peak on special order.
Coaxial contact. Inspection door, now open, snaps closed, giving constant impedence. Twinax contacts available.
Hand-tinning keeps solder inside cups.
All contacts, precision-machined from solid bar stock, electroplated with silver or gold.
Socket contacts are full-floating—turn through 360°. Quick, self-centering—eases inspection.
Highly legible contact numbers on insert faces.
Inserts of latest approved high dielectric materials.

Your requirements are responsible for the 8 to 10 design advantages found in each type of Cannon Plug. That's why engineers know the specification is right when it calls for CANNON. The DP Connector Series is just one of many Cannon types—world's most complete line. Request bulletins by required type or describe connector service you need.



Insert arrangements are available with 2 to 45 contacts ranging from 15 amp to 200 amp capacity. Continuous shielding available in Coaxial and Twinax. Metal finish on shells for shielding and bonding . . . tin plating on aluminum. Other finishes available on special request.



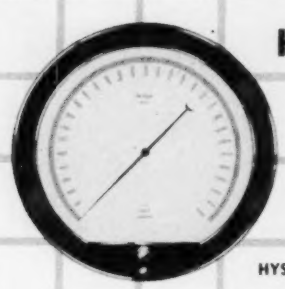
Type DPD Connectors are permanent installations in rack and panel equipment . . . mate automatically . . . have weight and space-saving advantages over other connector types.

CANNON ELECTRIC

Since 1915

LOS ANGELES 31, CALIFORNIA

REPRESENTATIVES IN PRINCIPAL CITIES



HEISE GAUGES

now used for PVT determination

TIGHT AGAINST MERCURY

HYSTERESIS LESS THAN ½ OF 1%

CONSTANT READING THROUGHOUT TEST

SENSITIVE TO SLIGHT CHANGES IN PRESSURE

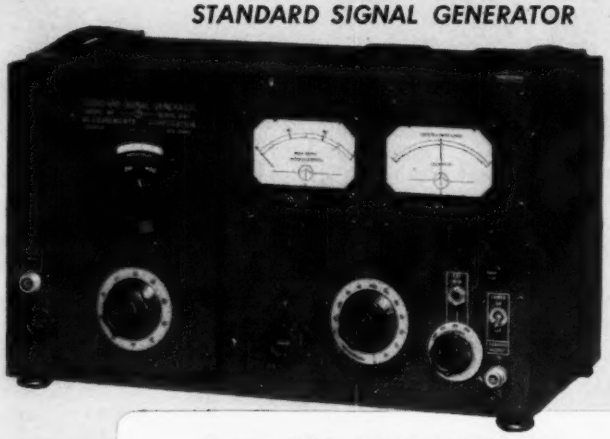
In repeated applications, Heise Bourdon Gauges have more than met the exacting requirements of PVT analysis. Exclusive Bourdon tube design and precision ball bearing movement provide inherent stability and accuracy throughout the pressure range.

Heise Gauges are used in many industries for precise measurements of pressure. Custom-built in pressure ranges from 0-15 to 0-10,000 psi. Sizes: 8½", 12", and 16" diameter. Standard gauges from $151.60 to $211.20. Gauges for use with mercury are $20.00 extra. Write for catalog.

Heise Bourdon Tube Company, Inc.
Newtown, Connecticut

MEASUREMENTS CORPORATION ***MODEL 80***

STANDARD SIGNAL GENERATOR



2 to 400 MEGACYCLES

MODULATION: Amplitude modulation is continuously variable from 0 to 30%, indicated by a meter on the panel. An internal 400 or 1000 cycle audio oscillator is provided. Modulation may also be applied from an external source. Pulse modulation may be applied to the oscillator from an external source through a special connector. Pulses of 1 microsecond can be obtained at higher carrier frequencies.

FREQUENCY ACCURACY ±.5%

OUTPUT VOLTAGE 0.1 to 100,000 microvolts

OUTPUT IMPEDANCE 50 ohms

MANUFACTURERS OF
Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UHF Radio Noise & Field Strength Meters
Capacity Bridges
Megohm Meters
Phase Sequence Indicators
Television and FM Test Equipment

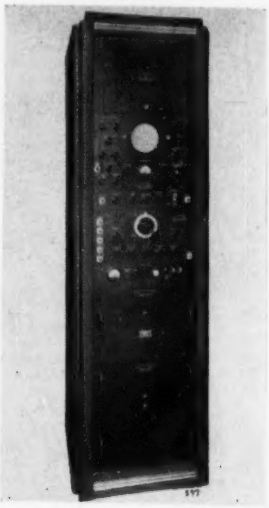
MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

from 50 cps to 10 Mc, and voltage scales, corresponding to power scales, are also provided. Since instrument gives a power reading for other than sinoidal wave forms, it is applicable to measurement of underwater sound and of noise, both at AF and RF. Oscilloscopic delineation of rapidly fluctuating power levels is provided through separate jack and switch to give adjustable feedback time constant. With a linear sweep, wave shown on oscilloscope is a plot of power versus time.—*Reed Research, Inc.*, 1048 *Potomac St., N. W., Washington 7, D. C.*

Mention No. 1150 when filling out card.

Oscillosynchroscope

New "Model OJ-17" oscillosynchroscope has a flat response from 5 cps. to 16 Mc., extending beyond 30 Mc., including use of a 0.2 microsecond signal delay line. Two separate sweep systems permit display of repetitive phenomena with recurrence rates as high as 10 Mc., or transient and recurrent pulses as short as 0.05 microseconds. Built-in trigger and delay generators



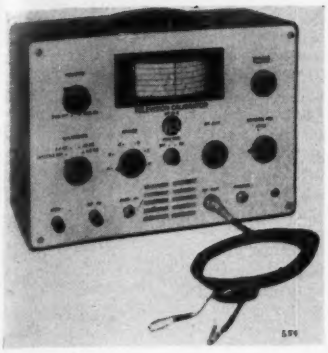
are provided for synchroscopic applications, as in radar circuits. Time measurements may be made by use of adjustable timing markers. Vertical signal amplitude measurements are possible using a direct reading deflection calibration system. High-voltage cathode-ray tube provides a trace sufficiently bright to be photographed under high-writing-rate single-sweep conditions. Instrument consists of five separate chassis units assembled in a rack cabinet mounted on casters. A compartment is provided for permanent installation of an "Oscillo-Record" camera. Over-all dimensions 82 x 23 x 24 in.—*Browning Laboratories, Inc., Winchester, Mass.*

Mention No. 1151 when filling out card.

TV Calibrator

New "WR-39B" TV calibrator includes crystal-calibrated marker generator with dual markers for all TV frequencies, bar-pattern generator, rebroadcast transmitter for all 12 chan-

UNIVERSITY OF MICHIGAN LIBRARIES

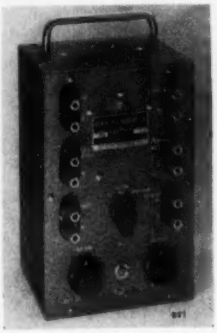


nels, heterodyne frequency meter, signal generator, and a dual-crystal standard with three crystals supplied.—*RCA Victor Div., Radio Corp. of America, Harrison, N. J.*

Mention No. 1152 when filling out card.

Intermodulation Set

New "Model 162" intermodulation set is used with customer's own oscillator (for one tone) and oscilloscope. Special

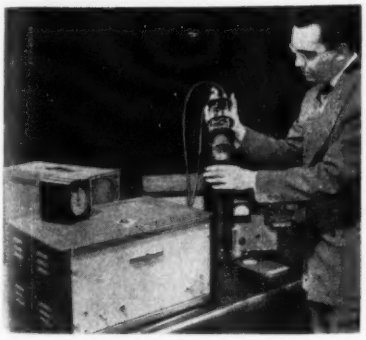


oscilloscope screen supplied enables direct measurement of percent intermodulation. Complete instructions cover method of analyzing screen images for distortion causes.—*Audio Instrument Co.*, 133 *West 14th St., New York* 11, *N. Y.*

Mention No. 1153 when filling out card.

Alpha-beta-gamma Counter

New "universal scintillation counter" provides low background alpha counting and high efficiency beta and gamma counting. Sampling chamber can accommodate specimens up to 2 in. in



A DEPENDABLE SOURCE FOR

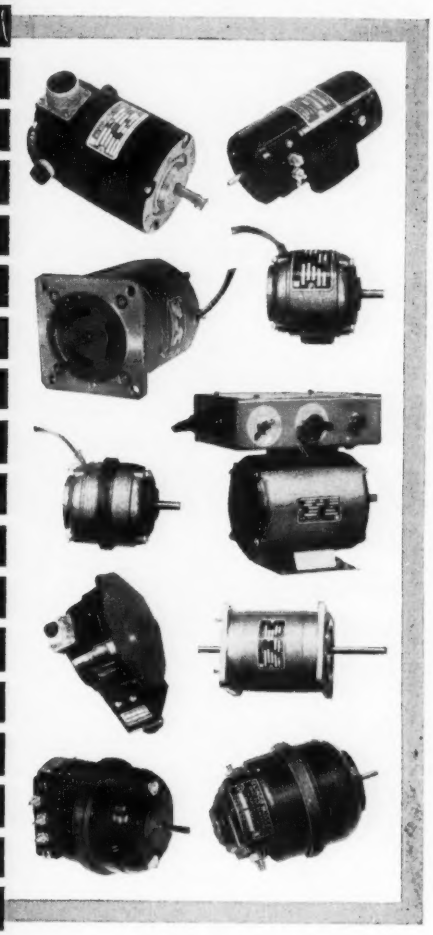
MOTORS and GENERATORS

DESIGNED AND PRODUCED TO ORDER

HIGH - PRECISION
FRACTIONAL H. P.
INSTRUMENT-TYPE

ELINCO

GOVERNOR-CONTROLLED
SELF-SYNCHRONOUS
DRAG CUP
DC & AC TACHOMETER
SHUNT
SERIES
COMPOUND
PERMANENT-MAGNET
SPLIT-FIELD
SEPARATELY EXCITED
UNIVERSAL
INDUCTION
RELUCTANCE
HYSTERESIS
ONE-, TWO- & THREE-PHASE
DC & AC SERVO
TOTALLY ENCLOSED
AC DYNAMICALLY BRAKED
REELMOTORS
ONE-, TWO-, THREE- & FIVE SPEED SYNCHRONOUS MOTORS



If you have a specific problem write for literature, or submit blueprints and complete details for our recommendations and quotation.

NOTE

Elinco produces only special high-precision instruments demanding the highest engineering ability and ingenuity, and manufactured with extreme care and skill. Every order is special . . . engineered and produced to the customer's own exact specifications, or by variations of one of our over-500 different basic models.

OVER 500 BASIC MODELS

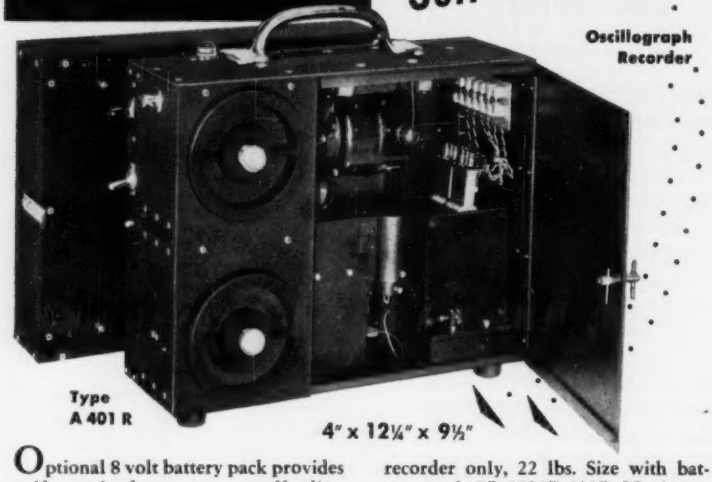
ELECTRIC INDICATOR CO.

PARKER AVENUE STAMFORD, CONN.

dependable instruments

Heiland
DENVER

Fully Portable
Self Contained



Optional 8 volt battery pack provides self contained power source affording maximum flexibility of application and portability.

Weight with battery pack, 39 lbs.; recorder only, 22 lbs. Size with battery pack 7"x12¼"x9½". Maximum of 6 channels. Paper 2" wide, 100' long. Available without battery pack for operation on 12 or 24 volts D.C.

Write for complete details

HEILAND RESEARCH CORPORATION · 130 East Fifth Ave. · Denver, Colo.

Put your high-vacuum requirements on a production line basis

The Eimac HV-1, oil-diffusion type vacuum pump, because of its construction features assures consistently dependable operation characteristics. When this high-efficiency pump is used with Eimac type A oil, an ultimate vacuum of 4 x10-7 mm of mercury may be reached.

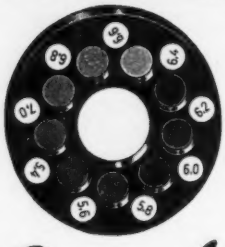
Rapid pumping speeds and simplicity of maintenance enable the HV-1 to produce more units-of-work during a period of time than conventional pumps of similar size. Write for complete technical data.

Eimac
HV-1 VACUUM PUMP

★ Clear Glass Pump Barrel
★ No Liquid Cooling
★ No Charcoal Trap
★ No Mechanical Wear
★ Maintenance without Special Tools or Skill
★ Simple Pipe Flange Vac-System Connection

WRITE

EITEL-McCULLOUGH, INC.
2283 San Mateo Ave., San Bruno, California



FOR
pH Control
and WATER TESTS
there is nothing like
NON-FADING
GLASS COLOR STANDARDS

Permanent reliability of Hellige Glass Color Standards and accuracy of color comparison are exclusive features of Hellige Comparators.

WRITE FOR BULLETIN No. 602

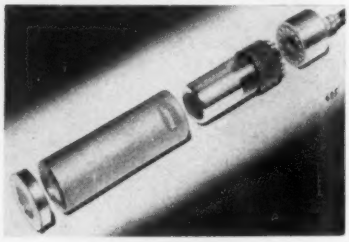
HELLIGE
INCORPORATED
3718 NORTHERN BLVD., LONG ISLAND CITY 1, N.Y.

diameter. When used as alpha counter, background is not more than a few counts per hour. Other features include short resolving time, 45 percent counting geometry, and no microphonics. Counting efficiency is 100 percent for thin samples. As a beta counter, device has high counting geometry, no filtration, high speed counting, and small change of characteristics with time. As a gamma counter it employs a liquid phosphor. For scintillation counting a sample is placed in slide chamber of unit. Particles strike a phosphor causing scintillation which is detected by photomultiplier tube.—*Special Products Div., General Electric Co., Schenectady, N. Y.*

Mention No. 1154 when filling out card.

Alpha Scintillation Probe

New "P-12" probe can be used with scalers and counting rate meters for selective measurement of alpha particles. Phosphor light pulse has decay time of

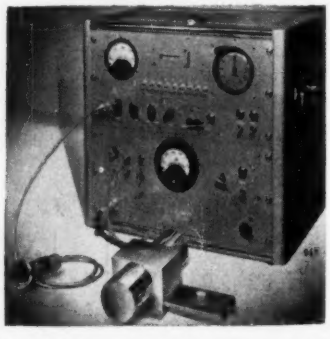


10 microseconds, and instrument is nonmicrophonic. Background of probe is 5 counts per hour, and it is insensitive to beta and gamma radiation. Accessories are available for radioassay work.—*Tracerlab, Inc.*, 130 *High St. Boston* 10, *Mass.*

Mention No. 1155 when filling out card.

All-purpose Scaler

New "Mark 9, Model 4" scaler has an input capacity of scaler section of 10 uuf, with sensitivity variable from 0.2 to 5 v. negative. Voltage range is



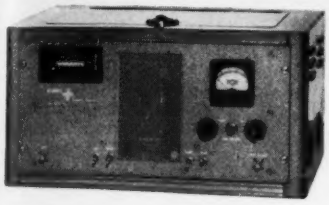
500 to 2000 v., and line voltage is 105-125 v. Linear amplifier section input is 10 mv. or larger pulses, with input rise time less than 2 microseconds and suration of 3 microseconds minimum. Gain is about 750, and resolving time is less than 5 microseconds. Preset count feature is available.—*Radiation Counter Laboratories, Inc.*, 1844 *W.* 21 *St., Chicago*, 8, *Ill.*

Mention No. 1156 when filling out card.

UNIVERSITY OF MICHIGAN LIBRARIES

Scaler

New "1010 Scaler" features optional scale-of-100 or scale-of-256, plug-in input and diode-coupled scaling strips, and resolving time of less than 5 microseconds. Inputs are probe of 0.25 v.

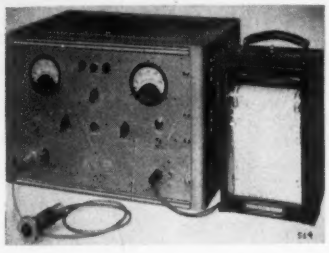


sensitivity and external preamplifier. Pulse height discriminator is adjustable. Line and load high voltage supply are regulated. Custom modifications include scale-of-1000 or scale-of-4096, and scaling factor selector switch. A calibrated −50 to −100 v. discriminator can be mounted on front panel, and an electrical reset register provided.—*Atomic Instrument Co., 84 Massachusetts Ave., Boston 39, Mass.*

Mention No. 1157 when filling out card.

Counting Rate Meter

New "Mark 15, Model 10" counting rate meter has five ranges indicating from 0 to 20,000 counts per minute.

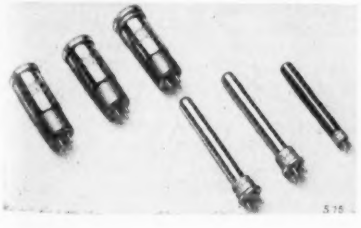


An internal circuit allows calibration against 60-cps. power supply. Accuracy is 3 percent full scale, with input sensitivity preset 0.25 v. Voltage range of 500 to 2000 v. is accurate to 2 percent full scale. Time constants of 3 and 33 seconds are standard. Line voltage range is 105-125 v.—*Radiation Counter Laboratories, Inc., 1844 W. 21 St., Chicago 8, Ill.*

Mention No. 1158 when filling out card.

Geiger Tube

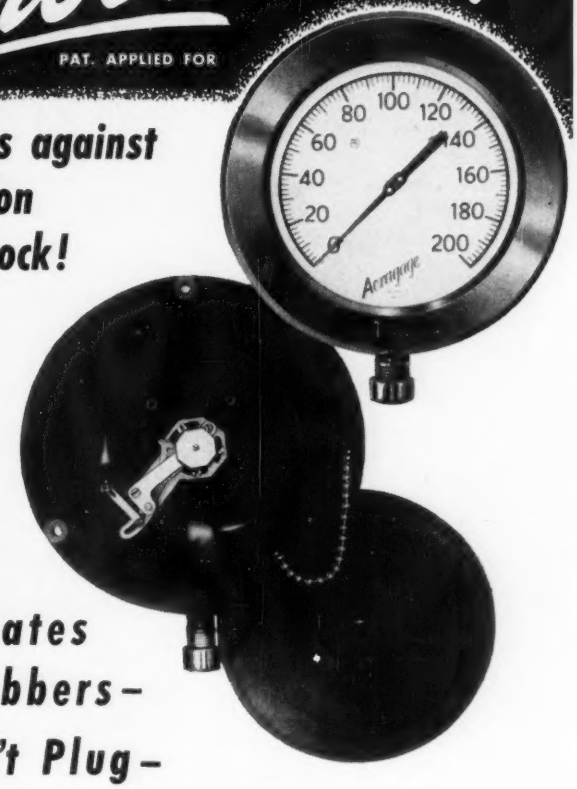
New Geiger tube has evaporated stainless steel cathode inside glass walls and on mica windows. Life of mica window tubes has been extended by a factor of ten over aquadag type and



ACRAGAGE

Shockstop!

PAT. APPLIED FOR



Protects against Pulsation and Shock!

Eliminates Snubbers— It Can't Plug—

The Most Significant Pressure Gage Development in 50 Years.

For the first time, a successful means of eliminating the effect of pulsation and shock on pressure gage mechanisms has been developed which DOES NOT introduce an orifice or restriction in the pressure connection.

It Can't Plug

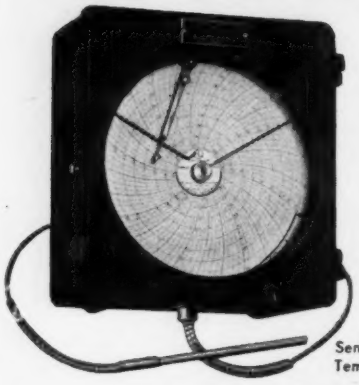
FOR COMPLETE INFORMATION, WRITE FOR CATALOG C-50

CLAPP INSTRUMENT CO.

WEBSTER, MASSACHUSETTS

AUTO-LITE

TEMPERATURE RECORDERS



For your specific needs!

★ Precision-built recorders provide money-saving proof of temperature behavior.

★ Low-cost protection . . . due to large scale, specialized production.

★ Wide selection of chart ranges.

★ 3 standard types; choice of 24 hour or 7-day movement.

Send for catalog showing Auto-Lite Temperature Recorders and Indicators.

Model "500" Temperature Recorder. Priced from $37.50.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

INDICATING & RECORDING THERMOMETERS

The *Accurate* Way to Measure Extreme Temperatures *at a glance*

The Simplified PYRO Optical Pyrometer

SELF-CONTAINED. No correction charts, no accessories, no up-keep. *Direct-reading.*

ACCURATE. Permits *close* and *rapid* temp. determination—even on *minute spots, fast-moving objects, smallest streams.* ("Special Foundry Type" and "Triple Range" also have RED Correction Scale for determining *true spout* and *pouring* temps. of molten iron, steel in the open.)

LIGHT IN WEIGHT—Only 3 lbs. complete. Handy.

PROVED IN USE—Thousands in daily use.

Stock Ranges 1400°F. to 7500°F.

Write for FREE Catalog No. 80—also catalogs on other PYRO Pyrometers

THE PYROMETER INSTRUMENT CO.
Plant and Lab.
BERGENFIELD 4, NEW JERSEY
In Canada, Sales and Repair Laboratory:
Dominion Flow Meter Company Limited
Toronto and Montreal

Engraving

PROFILING
VERTICAL
MILLING

Dies
Displays
Signs
Panels
Name Plates

Here is the most versatile machine...So simple to operate by unskilled labor.

NEW HERMES Engravo

This heavy duty bench type model covers a larger engraving area than any other machine of its kind.

Send for illustrated booklet H

NEW HERMES, Inc.
DEPT. 39
13-19 UNIVERSITY PL. • NEW YORK 3
World's Largest Manufacturer of Portable Engraving Machines

all-glass tubes also have increased life. Background of stainless-steel cathode tubes is lower than that of previous tubes, and use of stainless steel eliminates outgassing.—*Tracerlab, Inc.*, 130 *High St., Boston* 10, *Mass.*

Mention No. 1159 when filling out card.

Automatic Medical Diagnosing Instrument

New "Isotron" diagnoses brain tumors by measuring concentration of radioactive tracer which accumulates in tumor tissue. Two Geiger tubes take

readings at 32 spots on the head. Machine has two channels with scaling and count rate circuits, timing controls, and a circuit to calculate unbalance between channels. Tracer used is iodine in diiodofluorescein.—*Nuclear Instrument and Chemical Corp.*, 223-233 *W. Erie St., Chicago* 11, *Ill.*

Mention No. 1160 when filling out card.

Isotope Calculator

New calculator solves problems involving build-up of induced activity under radiation and of subsequent decay problems. Circular scale gives unlimited range with answers read directly in Curies per gram to an accuracy dependent on values of flux and cross sections used. Calculator is die-cut on plastic and includes complete instructions.—*Janet M. Cisar, P. O. Box* 1024, *Oak Ridge, Tenn.*

Mention No. 1161 when filling out card.

Light-weight Rotary Hydraulic Power Unit

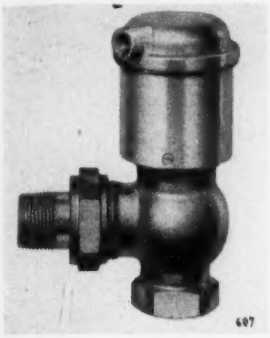
New "Model 167A Rotary Actuator" weighs 1lb. and develops maximum output of 110 in.-lbs., with rated load of 60 in.-lbs. Actuator produces non-linear torque output and requires one second for full shaft rotation under rated load. Shaft begins at high speed but closes at slow speed. Actuator has an adjustable slip clutch which compensates for hydraulic surge loads. Mechanical stops are used, with manual operator in case of power failure. Integral 26 v. d.c. split-series wound motor rated for intermittent duty cycle of one second on, five seconds off.—*Electro-Mechanical Div., Lear, Inc.*, 110 *Ionia Ave., N.W., Grand Rapids* 2, *Mich.*

Mention No. 1162 when filling out card.

UNIVERSITY OF MICHIGAN LIBRARIES

Piston-operated Valves

New line of control valves with piston operators is designed for proportional control of low-pressure steam, hot or cold water. They are made in 0.5 in. and 0.75 in. pipe sizes, in union angle, union globe reverse flow, double-union angle,

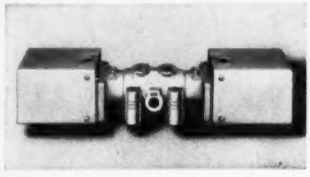


and female union inlet globe patterns. In water valves, a V-ring self-sealing packing adjusts automatically to correct sealing pressure at minimum stem friction. For low pressure steam, molded split-ring packings are readily accessible for adjustment of replacement.—*Johnson Service Co., 507 E. Michigan St., Milwaukee 2, Wis.*

Mention No. 1163 when filling out card.

Solenoid Hydraulic Valve

New "Series 5500" double-solenoid-operated 4-way hydraulic valve has hydraulically-balanced piston with integral spool and stem. Piston surface is hardened, ground and lapped. For pressures up to 1500 psi., valve is available



in 0.25, 0.375, 0.5, 0.75, and 1-in. sizes for standard 110, 220, and 440 v., 50 or 60 cps. current. Non-standard current specifications furnished upon request.—*Rivett Lathe & Grinder, Inc., Brighton 35, Boston, Mass.*

Mention No. 1164 when filling out card.

Hydraulic Relief Valve

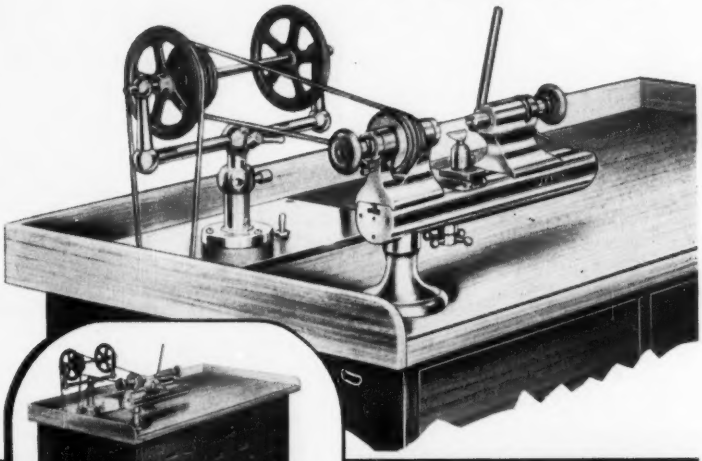
New cartridge-type relief valve with pressure settings from 100 to 5,000 psi., available for industrial use in housings ported for 0.375, 0.5 and 0.75 in. pipe has received AN certification in first two sizes.—*Hydraulics Div., Pantex Mfg. Corp., Pawtucket, R. I.*

Mention No. 1165 when filling out card.

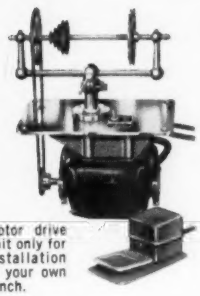
Miniature Flow Valves

New diaphragm-motor valves for small flows operate on 2 to 15 psi. air pressure. Body patterns are straight, angle, or 3-way, in 0.125, 0.25, and 0.5 in. pipe sizes. Over-all height of 0.25 in.

PRECISION LATHES and ACCESSORIES for SMALL WORK



Lathe with complete bench and motor drive.



Motor drive unit only for installation in your own bench.

LEVIN

AMERICA'S FINEST PRECISION JEWELER'S LATHES

Widely acclaimed as ideal for instrument work, second operations for production, tool work or experimental work and model making. Collet capacity 3/16" or 5/16".

Available with motor drive and bench or for separate mounting. Send for complete catalog and prices of lathes and accessories.

LOUIS LEVIN & SON, INC.
782 East Pico Blvd.
Los Angeles 21, Calif.

Visit the C R L School Booth — 615 — at Buffalo ISA Exhibit

The C R L School offers 2 year residence courses in

INDUSTRIAL INSTRUMENTATION-ELECTRONICS-TELEVISION

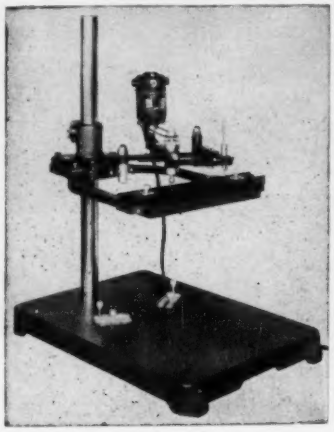
At Buffalo, Mr. Dana S. Merriman, C R L School Administrator, will be happy to answer your questions about:

1. C R L Training-Facilities. 2. C R L Grads to fill your personnel needs. 3. Major Industries who employ C R L Grads. 4. Group training or other special training ideas to fit YOUR specific needs.

Remember the C R L School Booth Number at BUFFALO—615.

CRL School of Electronics
29 Allyn Street, Hartford, Connecticut
Licensed by Conn. State Department of Education

MICO ENGRAVER
Model 253



A further adaptation of the already proven Mico Engraver, Model 252. Will perform accurate engraving on panels 19-inches wide and of unlimited length. Accommodates work up to 19-inches high.

Catalog on request

MICO INSTRUMENT CO.
86A Trowbridge Street
Cambridge 38, Mass.

FOR *Critical* TAPE RECORDING
to 40,000 cycles

Tape recording is superior to all other reproduction methods and "AMPEXED TAPE" has the greatest fidelity and range now possible. Simplified operation plus sure results make AMPEX unexcelled for all critical recording uses. Dual tape speeds with automatic speed and equalization change is but one of many exclusive AMPEX features. *Unequalled for*

TELEMETERING • BROADCASTING • RESEARCH

AMPEX STANDARD OF THE GREAT RADIO SHOWS

Simultaneous
• ERASE
• RECORD
• PLAY BACK
MODEL 300
Price $1575
(f.o.b. San Carlos)
Meter Control
Panel $114 Extra

AMPEX ELECTRIC CORP., San Carlos, California
Without obligation please send 16-page illustrated booklet containing technical specifications of Ampex Magnetic Tape Recorders.

NAME_____
ADDRESS_____
CITY_____ STATE_____
Our need is for:
☐ Laboratory Research ☐ Telemetering
☐ Multi-Channel Recording ☐ Industrial Recording
☐ Recording-Broadcasting ☐ Aerophysical Research

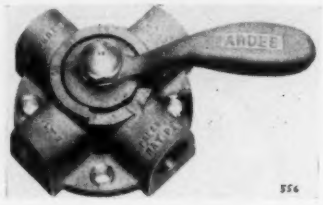
AMPEX ELECTRIC CORPORATION
SAN CARLOS, CALIFORNIA
DEALERS IN PRINCIPAL CITIES

valve is 8.875 in. Forged steel, stainless, or Monel bar-stock bodies are rated to 4000 psi. cold and 850 psi. at 1000 F. Stainless trim and Teflon packing are standard. Plugs available include linear, equal-percentage, and quick-opening.—*Research Control Instrument Co.*, 8211 *E. 7th St., Tulsa, Okla.*

Mention No. 1166 when filling out card.

4-way Valve

New "Ardee" 4-way valve is available in pipe sizes from 0.25 to 0.75 in. to handle air up to 150 psi. and liquids up to 1000 psi. Tubular sealing member



slides over peripheral surface of a rotor. Wiping action of sliding seal prevents foreign material in line from lodging between sealing surfaces. Bodies are available in aluminum and brass; and sealing members in resilient materials suitable for service requirements.—*Barksdale Valves*, 4905 *Santa Fe Ave., Los Angeles, Calif.*

Mention No. 1167 when filling out card.

Solenoid Valve

New "Model V2-100" solenoid valve has 0.125-in. NPT connections. All parts are plated, with soft synthetic seats and seals, and spring loading for

closing. Body is steel, rated at 125 psi. Coil is rated 10 watts max., continuous duty. Valve weighs 9 oz.—*Skinner Electric Valve Div., Skinner Chuck Co., Norwalk, Conn.*

Mention No. 1168 when filling out card.

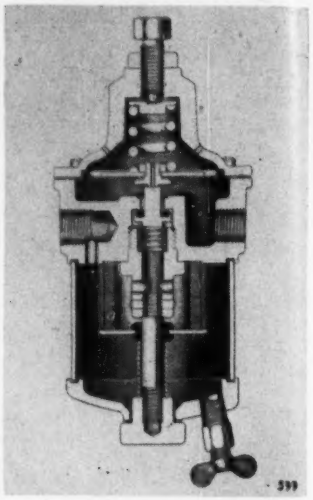
Adjustable-characteristic Valve

New "No. 235" adjustable lift-opening lever-operated control valve permits fixing valve lift at required position at any point within range of valve movement. Backlash is eliminated by spring action. Seats are furnished in sixteenth-in. dia. steps for single-seated and eighth-in. dia. steps for double-seated valves. Operating lever may be set for any position to accommodate linkage.—*Atlas Valve Co.*, 282 *South St., Newark, N. J.*

Mention No. 1169 when filling out card.

Instrument Air Filter and Regulator

New "Cono Airpak" is a combination of regulator, filter, and dripwell in a single unit, constructed of brass and stainless steel. Capacity is 25 cfm. Design permits horizontal or vertical

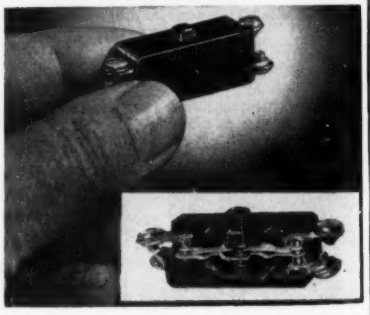


mounting. Filter medium is phenolic resin-impregnated cellulose capable of removing oil and water, and particles down to 40 microns. Three 0.25 in. N.P.T. taps permit multiple reducer pressure connections and integral pressure gauge mounting. Reduced pressure ranges available are 0-25, 0-50, 0-125 psi.—*Conoflow Corporation*, 2100 *Arch St., Phila. 3, Pa.*

Mention No. 1170 when filling out card.

Small Snap Switches

New line of small snap switches has broad selection of operating characteristics and actuating devices. Basic



switch is s-p-.d-t. for a-c. circuits. Various housings are available.—*Electro-Snap Div., Exhibit Supply Co.*, 4218-30 *W. Lake St., Chicago, Ill.*

Mention No. 1171 when filling out card.

Electron Microscope Lens

New removable intermediate lens extends magnification range in electron microscopy between 900 and 21,000 diameters, without breaking vacuum.

UNIVERSITY OF MICHIGAN LIBRARIES

Comes in metal instrument chest complete with gas sampling accessories

ACCURATE CO_2 Analysis in 40 Seconds!

Other outstanding features of the FYRITE CO_2 Indicator are its durable, fool-proof construction and unmatched convenience of operation. It requires no setting-up, has no valves or leveling bottle to manipulate.

The FYRITE measures CO_2 directly by the fundamental method of chemical absorption. Consequently, the reading is independent of voltage, humidity, temperature, or atmospheric pressure conditions.

Comes complete with chemical charge good for at least 300 readings. Replacing chemical merely requires removing four screws that hold top assembly in place.

Write for Bulletin 740

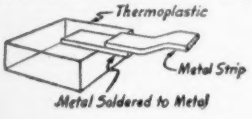
BACHARACH Industrial Instrument Company

7000 Bennett Street • Pittsburgh 8, Pa.

Low Temperature Soldering Problem Solved!

CERROSEAL-35 *Flows at 260° F.*

Manufacturer's Problem: To join two pieces of metal, one of which is bonded to a thermoplastic which must not be distorted by heat. Ordinary solders not satisfactory or practical.



The Solution: Extremely low-melting CERROSEAL-35, flowing at 260° F. Solders parts perfectly without harm to plastic.

● Cerroseal-35 was originally developed for use in making vacuum seals in laboratory apparatus between glass and metal tubing, has been proven invaluable for soldering metal to metal where the absolute minimum of heat applied and ease of application are essential.

Send for free descriptive literature outlining the uses for CERROSEAL-35.

Sample and instructions on request.

C de P Reg. Trademark

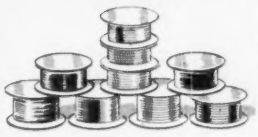
CERRO de PASCO Copper Corporation

Dept. 18 • 40 Wall Street • New York 5, N. Y.

Industrial . . .

Manufacturer of 58 Types of Insulated Thermocouple Lead and Special Wiring!

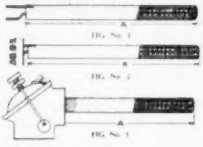
WIRES



Our manufacturing "know-how" assures you uniformity in lead wiring and service when it counts most.

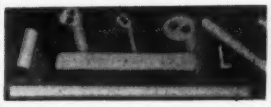
THERMOCOUPLE HEADS

THERMOCOUPLES



Base metal, noble metal types including immersion thermocouples for glass plants.

INSULATORS

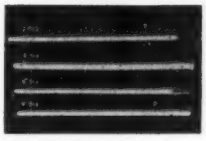


Porcleain bead (fish spine beads) —hot junction, double bore for platinum or base metal thermocouples.

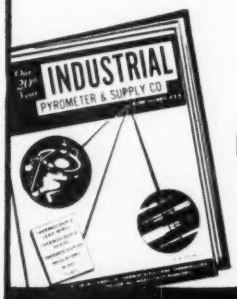
THERMOCOUPLE LEAD WIRES

Iron constantan, copper-constantan, chromel-alumel, platinum, rhodium, calibrated for all makes pyrometers.

TUBES



Silicon, fire brick and white heat porcelain types.



FREE CATALOG IN ACTUAL COLOR

Illustrating 58 types insulated and bare thermocouple lead wire in code color, supplies, calibration milivolt tables, wire resistance, etc.

INDUSTRIAL

PYROMETER & SUPPLY CO.

A. L. HACK, *President*

ALTON, ILLINOIS

PLUG-IN UNITS

STANDARD or to SPECIFICATION

Utilization of WALKIRT individually packaged counters, amplifiers, delay multivibrators, pulse generators, and other associated plug-in computer elements will provide substantial engineering, production, and maintenance savings.

PULSE CIRCUIT TECHNICIANS
MINIMIZED PACKAGING ENGINEERS

The WALKIRT Co.
5808 MARILYN AVE., DEPT. I
CULVER CITY, CALIF.

ELECTRONICALLY REGULATED

LABORATORY POWER SUPPLIES

RACK MODEL 32

- STABLE
- DEPENDABLE
- MODERATELY PRICED

- **INPUT:** 105 to 125 VAC, 50-60 cy
- **OUTPUT #1:** 200 to 325 VDC at 300 ma regulated
- **OUTPUT #2:** 6.3 Volts AC CT at 5A unregulated
- **OUTPUT #3:** 6.3 Volts AC CT at 5A unregulated
- **RIPPLE OUTPUT:** Less than 10 millivolts rms

STANDARD RACK MOUNTING PANEL SIZE 10½" x 19" DEPTH 9" WEIGHT 38 LBS

For complete information write for Bulletin N-2

LAMBDA ELECTRONICS CORPORATION
CORONA NEW YORK

Values may be changed by turning a knob on control panel. New lens provides a full field of view at all magnifications. It replaces intermediate chamber casting and viewing screen, and connections to coil are brought out in a shielded cable to control panel.—*RCA-Victor Div., Radio Corp. of America, Camden, N. J.*

Mention No. 1172 when filling out card.

High-speed Wide-angle Lens

New "Wide-angle Balowstar" 12-element coated lens stops down to f/1.3, with 15 mm. focal length. Lens can be used on standard 16 mm. camera turrets without interfering with fields of other lenses on turret. It has a free film distance of 15.5 mm.—*Zoomar Corp., 381 Fourth Ave., N. Y. 16, N. Y.*

Mention No. 1173 when filling out card.

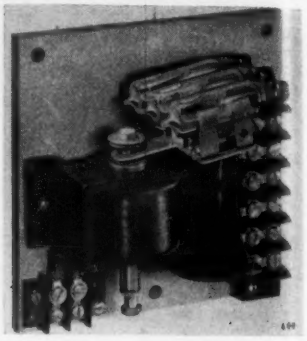
Sealed Relay

New "Part 8744-1" relay is hermetically sealed, with solder lug terminals and three studs for mounting. Ratings up to 3 amp., in contact combinations up to 4-p.d-t. Over-all dimensions 1.5 x 1.625 x 1 in.—*Advance Electric and Relay Co., 2435 N. Naomi St., Burbank, Calif.*

Mention No. 1174 when filling out card.

Mercury Relay

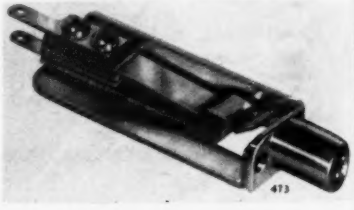
New "Type 600" relay has 1 to 5 tilt type mercury switches, rated 35 amp., 115 v., or 20 amp., 230 v., a.c., heater load. Designed for minimum of 6 million operations at rated load. Available with metal or plastic cover, size 6 x 6 in.—*Electronic Apparatus Corp., 116 E. Jackson Blvd., Elkhart, Ind.*



Mention No. 1175 when filling out card.

Telephone-type Jack

New "1399-B" telephone-type jack for patch panels incorporates nickel-silver contact springs, pure silver contact, and 0.0625-in. frame.—*Cinema Engineering Co., 1510 W. Verdugo Ave., Burbank Calif.*



Mention No. 1176 when filling out card.

Low-torque Voltage Divider

New low-torque voltage divider has a shaft torque of 0.003 in.-oz. Resistance values between 50 and 200,000 ohms are available, with currents up to 100 ma. Instructions are supplied with ball, sapphire, or bronze bearings, and shaft is sealed against dust. Toroidal wire-wound resistance element uses non-corrosive alloys. Insulating parts have fungicide treatment and metal parts are plated. Accuracies as high as 0.05 percent are available, and unit operates under vibrations up to 200 cps. Unit is 1.5 in. long x 1.25 in diam-

UNIVERSITY OF MICHIGAN LIBRARIES

SPECIFY PHILADELPHIA!

THERMOMETERS & THERMAL CONTROLS

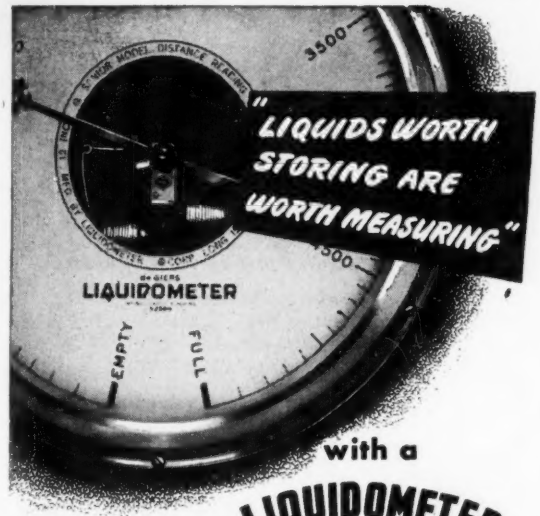
and you specify the **BEST**

We make the types needed in plants and industrial processes. Call upon our specialized staff to assist you with any problem arising in our field.

SEND FOR OUR CATALOG NO. 110

THE PHILADELPHIA THERMOMETER CO.

4400 N. SIXTH ST., PHILADELPHIA 40, PA.



with a **LIQUIDOMETER** *Tank Gauge*

- FOR GAUGING LIQUIDS OF ALL KINDS
- 100% AUTOMATIC
- APPROVED BY UNDERWRITERS' LABORATORIES

WRITE FOR COMPLETE DETAILS

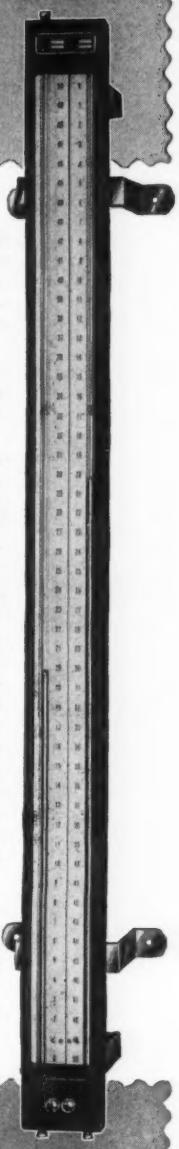
THE LIQUIDOMETER CORP.

36-27 SKILLMAN AVE., LONG ISLAND CITY, L.I., N.Y.

Announcing the

DUAL-TUBE

Something Brand New in MANOMETERS by MERIAM



• Now, instead of standing on a step ladder—as when reading long range, single column manometers—the operator can read high range pressures, vacuums, and differentials from the floor level.

This new manometer development—the DUAL-TUBE, Meriam Model M-100 — consists of two separate manometer tubes in the same case—each tube with individual well. The left tube has a scale increasing upward; the right tube a scale increasing downward. Both tubes are connected in parallel to the same pressure source.

The instrument is ideal as a calibrating standard manometer for checking flow meters, pressure gauges, and other secondary units operating on pressure or vacuum principle. It is direct reading. Since both tubes indicate the same reading, the operator can choose the one most convenient.

It helps avoid accidents, saves time and effort in reading. Of simple, rugged construction, it is built in accordance with Meriam standards of accuracy and sensitivity for long, reliable service. Ask for Catalog Sheet M-100WM.

THE MERIAM INSTRUMENT COMPANY

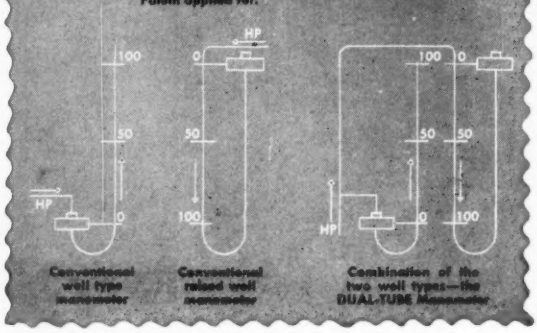
10950 MADISON AVENUE • CLEVELAND 2, OHIO

WESTERN DIVISION:

1410 Wilson Ave., San Marino 9, Calif.

IN CANADA: Peacock Bros., Ltd., Montreal

MERIAM DUAL-TUBE MANOMETER. Available in ranges of 50" to 150". Patent applied for.



Compare for *results!*
Compare for *price!*
and you'll choose the GREEN ENGRAVER

only $215*

The Green Engraver offers great speed and convenience. Quickly cuts up to four lines of letters from 3/64" to 1" on curved or flat surfaces whether made of metal, plastics or wood . . . operates by merely tracing master copy — *anyone* can do an expert job. Special attachments and engineering service available for production work. Just the thing for radio, electronic apparatus and instrument manufacturers.

For *quality* engraving on
• Molds • Panels • Scales • Dials • Lenses • Instruments • Name Plates

. . . also does routing, profiling and three dimensional modeling.

**Price does not include master type and special work holding fixtures.*

GREEN INSTRUMENT CO.

GREEN

367-A Putnam Ave.
Cambridge, Mass.

Here's Why I Specify

STEINEN
• SCREW MACHINE PRODUCTS
• STAMPINGS Metal—Plastic Fibre—Phenolite
• ASSEMBLIES Sub & Complete

because* STEINEN *offers
✓ Engineering Cooperation
✓ Precision Manufacture

Send Us Your Inquiries

Wm. Steinen Mfg. Co.

STEINEN

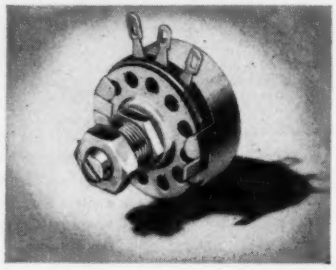
45 Bruen St. Newark 5, N. J.

eter, and weighs 1 oz. It will operate when subjected to accelerations of 100 g. —*Electro-Mec Laboratory*, 225 *Broadway, N. Y. 7, N. Y.*

Mention No. 1177 when filling out card.

Voltage Divider

New "Type AB" 2-watt voltage divider with linear taper has screw driver shaft and locking nut. Resistance values range from 50 ohms to



5 megohms. A s-p.d-t. switch can be attached to back of unit.—*Ohmite Mfg. Co.*, 4974 *W. Flournoy St., Chicago* 11, *Ill.*

Mention No. 1178 when filling out card.

Laboratory Conductivity Cells

New laboratory conductivity cells with constants 0.1, 1, and 10, are of tubular Pyrex glass construction and maximum diameter of 0.625 in. They are designed for minimum immersion and small sample volume.—*Industrial Instruments, Inc.*, 17 *Pollock Ave., Jersey City, N. J.*

Mention No. 1179 when filling out card.

Conductivity Cell

New conductivity cell with fittings for mounting in 1 in. sanitary pipelines consists of Pyrex glass member mounted in shielded Type 316 stainless

steel fitting. It is available with both low and high cell constants.—*Industrial Instruments, Inc.*, 17 *Pollock Ave., Jersey City* 5, *N. J.*

Mention No. 1180 when filling out card.

Rheostat Knob-shaft

New "Type FKS-¼" finger-tip knurled and screwdriver-slot "Pick-A-Shaft" snaps on to any "Type AM" or "AT" rheostat. It protrudes only 0.25 in. beyond control-unit bushing. A light blow snaps shaft rigidly and permanently on to control-unit.—*Clarostat Mfg. Co., Inc., Dover, New Hampshire.*

Mention No. 1181 when filling out card.

Pentagrid Amplifier

New "5915" 7-pin miniature pentagrid amplifier tube is designed especially for gated-amplifier service such as is found in computing-machine circuits. Grids No. 1 and 2 can each be used as independent control electrodes.—*RCA Victor Div., Radio Corp. of America, Harrison, N. J.*

Mention No. 1182 when filling out card.

Magnetic Base Lamp

New "Model 200" magnetic base lamp mounts on iron or steel surfaces. Universal ball and socket, and swivel arm,

support shielded 40 watt bulb. Shield has heat insulating coating. Plastic lamp cord is oil resistant.—*Enco Mfg. Co.*, 4522 *W. Fullerton Ave., Chicago* 39, *Ill.*

Mention No. 1183 when filling out card.

Instrument Oils

New oils, developed for small low-torque bearings, have nearly eliminated creeping tendencies of cenventional petroleum oils. Oils are low in volatility, resistant to oxidation, and may be used in pivot-to-jewel or pivot-to-brass bearings over "prolonged periods of time" without gumming.—*Gulf Oil Corp., Gulf Bldg., Pittsburgh, Pa.*

Mention No. 1184 when filling out card.

Silver-type Storage Battery

New "Model No. A-1-HR-1" of silver-type storage battery described in March '50 *Instruments*, p. 270, is less than 1 cu. in. in volume and weighs less than 1 oz. It will discharge at rates up to 5 amp. for 20 min. or 30 amp. for shorter times. Battery is spillproof, shockproof, and free of corrosive fumes. —*Yardney Electric Corp.*, 105-107 *Chambers St., New York* 7, *N. Y.*

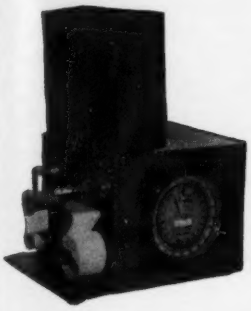
Mention No. 1185 when filling out card.

High-voltage Probe

New "100X Kilovolter" is a heavy-duty 8½-in. long probe that multiplies existing ranges of any standard 10- or 11-megohm VTVM by a factor of one

UNIVERSITY OF MICHIGAN LIBRARIES

A RECORDING MECHANICAL COUNTER



Actuated by an Electrical Impulse

it operates on the output of a scaler, photo tube, or other electrical unit . . . permanently records counts on a 2¼" tape . . . automatically resets to zero.

In Radioactive Research it saves precious time by eliminating many hours of manual labor, resulting in greater economy and efficiency.

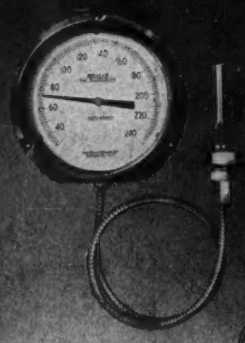
In industry it maintains a permanent record automatically, recording production and time each hour.

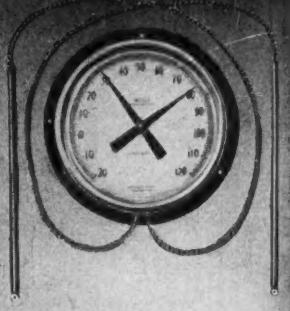
Write for complete information and illustrated circular SC 13.

STREETER-AMET COMPANY

AUTOMATIC WEIGHT RECORDERS & SCALES
HIGH SPEED COUNTERS SINCE 1888
4101 Ravenswood Ave., Chicago 13, Illinois

FOR CONSTANT DEPENDABILITY *Install* MOELLER DIALS and RECORDERS

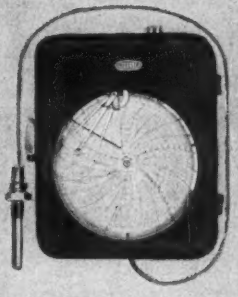




Remote Reading Type, Mercury actuated with separable socket connection. Back connection or flush mounting.

Duplex, mercury actuated, plain bulb type indicates temperatures at two separate points.

TEMPERATURE RECORDING TYPE



Single and multiple pen, Remote Reading types in rectangular or round cases.

Moeller Dial or Recording Thermometers can be furnished with electrical contacts.

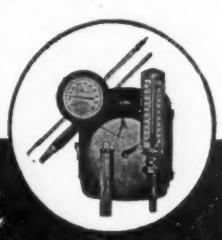
FOUR GENERATIONS have depended upon the accuracy of Moeller instruments.

FOUR GENERATIONS have relied upon the unfailing precision of all Moeller products.

Eighty years of such confidence in proven performance establishes the name Moeller as a guarantee of perfection in the engineering and manufacture of temperature indicating and recording instruments.

Send for catalogs and literature on

INDUSTRIAL, LABORATORY AND RECORDING THERMOMETERS
THERMOSTATS • HYGROMETERS
HYDROMETERS • PSYCHROMETERS
AND MARINE SPECIALTIES



MOELLER INSTRUMENT COMPANY

132nd ST. and 89th AVE. • RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

Just published

"HEAT INERTIA" IN PROBLEMS OF AUTOMATIC CONTROL OF TEMPERATURE

By VICTOR BROIDA
Consulting Engineer and
Process Control Specialist,
PARIS, FRANCE

A new treatment, based on the concept of the "fictitious mass" of the heat-process unit under automatic control.

Mathematical? Of course, but Dr. Broida's method can be mastered by anyone who has taken first-year differential equations. Many users have found it as handy as if they had the ENIAC at their disposal.

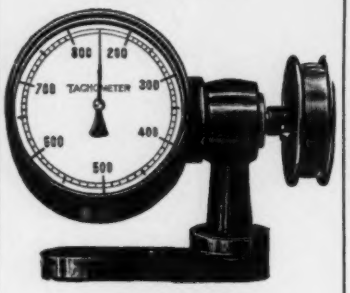
Stiff paper, 5¼ x 8¼ inches, 64 pages

$1.00 POSTPAID

Payment must accompany order

INSTRUMENTS PUBLISHING COMPANY
921 Ridge Ave. Pittsburgh 12, Penna.

Amthor



STATIONARY TACHOMETERS

CENTRIFUGAL TYPE

Indicating R.P.M., F.P.M., etc.
Belt, Sprocket, or Flexible
Shaft Drives

Models available for practically every requirement.

Immediate and intelligent attention will be given to your inquiries on all industrial speed measurement problems. Drop us a line today.

Amthor Testing Instrument Co., Inc.
49a Van Sinderen Ave. Brooklyn, N. Y.

CLEANING?

Don't tear down your instruments!

The ENG-SOL Method of Precision Parts cleaning now makes it possible to whisk away fingerprints, oil, grease, dirt, lapping compounds, abrasives, lint, or other contamination.

Our bulletin "Precision Cleaning" describes this new high-velocity compressed air method of cleaning.

Send for it—today.

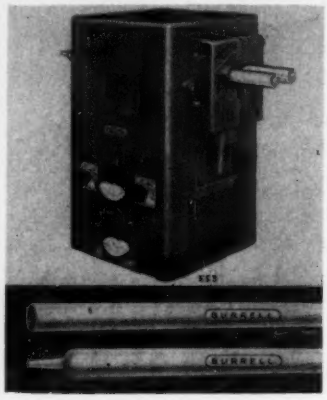
PASSAIC ANALYTICAL LABORATORIES, Inc.
228 Aycrigg Ave. Passaic, N. J.

hundred. Fitted with a clear Lucite nose piece and red barrier insulator, probe is designed for testing high-voltage circuits in TV receivers.—*Insuline Corp. of America, 3602-35th Ave., Long Island City* 1, *N. Y.*

Mention No. 1186 when filling out card.

Combustion Tubes

New refractory combustion tubes are available in McDanel (mullite) for temperatures up to 2900 F., and Zircum



(zircon) to same value. Both tubes are available in a variety of lengths and dia. with straight or tapered ends.—*Burrell Corp., Pittsburgh, Pa.*

Mention No. 1187 when filling out card.

Light-concentrator for Instrument Shops

New light concentrator can be attached to any frosted light bulb from 40 to 100 watts. Spot of illumination is 4 in. diameter, 12 in. from bulb. Brightness of work area is improved

five times by fresnel type of plastic lens 0.125 in. thick x 2.5 in. diameter, with focal length of 2.5 in. Weight is less than 1 oz.—*Clarkstan Corp.*, 11921 *W. Pico Blvd., Los Angeles* 64, *Calif.*

Mention No. 1188 when filling out card.

Wire-wound Resistors

New "Types BX120, BX140, and BX160" have both terminals at same end, and are designed to meet JAN requirements. Over-all dimensions and maximum resistance ratings are same as maker's "Akra-ohm" precision wire-wound types from which new end terminal arrangement was evolved. Wire leads instead of terminals can be furnished if desired.—*Shallcross Mfg., Collingdale, Pa.*

Mention No. 1189 when filling out card.

Thermoscopic Lacquer

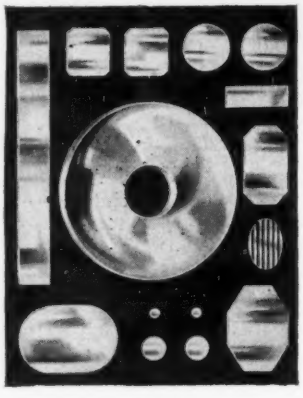
New ratings of "Tempilaq" will indicate from 1650 to 1950 F. Beginning with 113 F., material is now available

in 1.25 deg. steps to 400 F. and in 50 deg. steps from 400 to 1950 F.—*Tempil Corp.*, 132 *W.* 22 *St., N. Y.* 11, *N. Y.*

Mention No. 1190 when filling out card.

Front-surface Mirrors

New front-surface mirrors are made by thermal evaporation of an aluminum alloy under high vacuum. Reflecting surface is protected by a hard transparent, coating. Mirrors have reflectivity of 93 percent in visible spectrum.—*Zenith Optical Laboratory*, 123 *W.* 64*th St., New York* 23, *N. Y.*



Mention No. 1191 when filling out card.

CORRECTIONS

High-speed Multichannel Sampling Switch, The Applied Science Corp. of Princeton (August issue, page 815). After "30 break-before-make channels per second," there should have been added the words "at a speed of 30 rps." to make it clear that the sampling rate is 900 channels per second.

Self-operated Temperature Controller, Farris Stacon Corp. (August issue, page 804). Single unit is available in sizes 0.25 in. to 1.5 in. and not to 6 in. Only the pilot-operated models are available in the larger sizes.

UNIVERSITY OF MICHIGAN LIBRARIES

Volume 6 September 1950 Number 9

Journal

Officers

President: R. J. Pigott

First Vice President: J. B. McMahon

Vice President: Dr. O. A. Beckman

Vice President: Nelson Gildersleeve

Vice President: Porter Hart

Treasurer: H. E. Ferguson

Secretary: Richard Rimbach

ISA National Office: 921 Ridge Ave., Pittsburgh 12, Pa.

National Committees and Chairmen

Committee for Analysis Instrumentation, D. J. Pompeo; Constitution & Rules & Procedures Committees, J. B. McMahon; Coordinating Committee, E. S. Lee; Employment Committee, C. F. Goldcamp; Finance Committee, G. R. Feeley; Historical Committee, S. W. Prince; Instrument Maintenance & Operation Committee, L. C. Laird; Committee on Instrumentation for Production Processes, D. M. Boyd; Instrumentation for Testing Committee, W. A. Wildhack; Instrumentation for Transportation Committee, F. H. Catlin; Instruments for Inspection & Gaging Committee, R. L. Geer; Meetings Committee, E. J. Grace; National Defense Committee, R. L. Goetzenberger; Nominating Committee, A. F. Sperry; Publications Committee, L. H. Allen, Jr.; Recommended Practices Committee, W. H. Fortney; Sections & Membership Committees, M. S. Jacobs; Society Structure & Planning Committee, A. H. Shafer.

SECRETARY'S PAGE

I WANT to talk to you briefly about ISA, and I want each of you to think about ISA. Further I want to bring to you, in a general way, the status of our present position and what you, as a member, can do to expand and improve our activities and growth.

As you all know ISA was organized in 1946 by men representing their local groups. These groups had been brought together locally by mutual problems in measurement and control. These groups had recognized the need for a society devoted exclusively to the rapidly developing branch of engineering dealing directly with instrumentation in its various phases; instrumentation education, recommended practices and the exchange of information for the mutual solution of instrumentation problems.

In the November 1944 issue of *Industrial and Engineering Chemistry*, St. Louis ISA member Ralph Munch wrote:

"Our need for instrumentation stems from a desire to obtain better yields of purer products from poorer raw materials with less capital investment and less labor. Batch processes usually require a minimum of instrumentation. There is generally time for manual measurement of important process variables, such as p*H*, or for chemical analysis to determine completeness of reaction. When, in our effort to improve quality and lower costs, we go to continuous processes, it becomes imperative that we have methods which will indicate without lag the condition of the process at each of its important stages. During the time required to run control tests suitable for batch processes, a continuous one may get so far out of balance as to require hours to correct and may make large quantities of off-grade product during that time. In other cases serious danger to personnel and damage to equipment may result."

ISA is a voluntary, non-profit organization. The most important feature of the ISA is that it brings together men who have an interest in instrumentation. The interchange of ideas among these men will accelerate the advance of instrumentation.

Certainly, our society is well justified, and it is no small wonder that our membership has grown phenomenally and continues to grow.

Our members are receiving many valuable services and you may be sure that all committees of the Society are doing everything in their power to increase and improve the services you receive. Permit me to tell in a general way but briefly, about these services: Journal of ISA, Annual Conference and Exhibit, ISA Proceedings, Reports of the Recommended Practices, Employment Service.

As you will find, the Instrument Conference and Exhibit is, in effect, a market place for the exchange of new ideas, news and information on instrumentation—scientific and industrial. As a matter of fact, you might call it a three-way affair. First it provides an opportunity for the users of instruments to get together and exchange ideas and information; second, it provides an opportunity to tell the representatives of the instrument manufactures what is on your mind, your needs and problems; and third, of course, the instrument manufacturers can inform you of their new developments. I am sure all of you have plenty of problems and you can look to the instrument manufacturers for their solution.

Frankly speaking, there are many jobs yet to be done—and for these we must look to our members. It is not my intention to get personal, but—*What are you doing to aid in the work of ISA?* Also, we should have more members. The whole group of us must shoulder and assume our share of the responsibility. We simply cannot stop where we are and let "George do it." ISA is a young organization.

ISA offers all those with an interest in measurement and control an opportunity to increase their knowledge of instrumentation.

—RICHARD RIMBACH
Secretary

TREASURER'S REPORT

ISA Fifth National Conference, September 12, 1950

DURING 1948 and 1949, the Budget and Finance Committees developed and put into operation at the Society Headquarters Office an accounting and budgetry control system specifically designed to meet the needs of the Society. During the past sixteen months this system has provided accurate recording of receipts and expenditures, and a satisfactory control of the disposition of the Society moneys. Major factors in the smooth and efficient handling of the accounting operations have been the careful work of the Assistant Secretary, John J. McCaffery, the supervision of the Secretary, Richard Rimbach, and the counsel of the Auditor, J. A. Hollingsworth.

The financial condition of the Society on June 30, 1950, is indicated in a summary sheet at the end of the report —("Statement of Condition," prepared by Mr. Hollingsworth as C.P.A.). Total assets of the Society on June 30, 1950, were $73,775.08—consisting essentially of $10,000 invested in government bonds, and $62,713.12 in cash deposited in four banks. (The residual $422.69 was transferred from the Live Stock National Bank of Chicago to the West End Bank of Pittsburgh during August.) Against the $62,713.12 in cash assets, there were liabilities of $39,094.18 held in reserve until the conclusion of the Fifth National Exhibit and Conference, and $406.80 in salary taxes —so that the indicated total surplus of $34,274.10 included an operating or cash surplus of $23,212.14.

During the first six months of 1950, the revenue of the Society (exclusive of exhibit prepayments) was $21,811.78, and its expenditures totaled $32,183.09 —expenses thus exceeding income by $10,371.31. This is a perennial situation. Each year, from November to the following September, the necessary expenses of the Society are $12,000-$14,000 greater than the unattached revenues during the same period. Then in each September the annual exhibit, and the fall membership dues, make sufficient money available to not only offset the deficiency of receipts versus expenses, but to provide a surplus of $12,000-$14,000 at the end of the year (see third table). As long as its receipts during the first nine months of a year are considerably smaller than its expenses during the same period, it is necessary that the Society have a sizeable surplus at the end of the preceding fiscal year.

This inadequacy of income during most of the year may not endanger its solvency, but it can be interpreted as indicating that the Society has not, as yet, progressed much beyond a stage of adolescence. Until the month-by-month revenues of the Society are increased so that they more nearly approximate the month-by-month expenses (preferably by an increase in membership), and until it is not so necessary to depend so much on the September harvests, much prudence should be exercised in undertaking any activities requiring major expenditures or which cannot guarantee financial profit to the Society.

In addition to the "Statement of Condition" and the "Summary of Income and Expense, January 1 to June 30, 1950," which were prepared by the Society's Auditor, at the end of the report is a table summarizing annual receipts and expenditures since the organization of the Society in 1946. The total of the annual surpluses to 1949, and the 1950 mid-year surplus, is $74,190.64. The Auditor reports the total assets of the Society at the 1950 mid-year to be $73,775.08. The difference of $415.56, is in part petty cash at the headquarters office, and in part an error of $215.55 in the cash reported in the Live Stock National Bank (which should have been $422.69 instead of only $207.14).

Sight should not be lost of the fact that, although during the past four years the Society has had annual surpluses totalling $74,190, and has been reported by a certified auditor and accountant to have *total* assets of $73,775, as was pointed out at the start the available or unattached working capital at the middle of the year was only $23,212.

Respectfully submitted,
HUGH E. FERGUSON
National Treasurer.

THE INSTRUMENT SOCIETY OF AMERICA
Statement of Condition
June 30, 1950

ASSETS		
Cash in Banks		
Live Stock National, Chicago	$ 207.14	
Bank of Nova Scotia	1,784.05	
West End Bank, Pittsburgh	36,264.74	
Farmers Deposit National, Pittsburgh	24,457.19	
		$62,713.12
Investments		
U. S. Treasury Bonds, Series G		10,000.00
Prepayments (Payroll checks recorded)		1,061.96
TOTAL ASSETS		$73,775.08
LIABILITIES AND SURPLUS		
Reserve for 1950 Exhibit		$39,094.18
Employees withheld taxes		406.80
Surplus		
Balance January 1, 1950	$44,645.41	
Less: Excess of expense over income January 1 to June 30, 1950	10,371.31	34,274.10
TOTAL LIABILITIES AND SURPLUS		$73,775.08

THE INSTRUMENT SOCIETY OF AMERICA
Summary Statement of Income and Expense
January 1 to June 30, 1950

INCOME		
200 Memberships		$20,872.21
400 Registration		198.95
600 Exhibits (Deferred)		—
1000 Administration		740.62
TOTAL INCOME		$21,811.78
EXPENSE		
100 Memberships		$16,787.96
300 Meetings and Conferences		1,601.16
500 Exhibits		3,721.18
700 National Headquarters		9,246.29
900 Administration		826.50
TOTAL EXPENSE		$32,183.09
Excess of Expense Over Income		$10,371.31

THE INSTRUMENT SOCIETY OF AMERICA

Summarization of Receipts and Expenditures, 1946 to 1950

Account Numbers	*EXPENDITURES*	*3 Months 1946*	*12 Months 1947*	*12 Months 1948*	*12 Months 1949*	*6 Months 1950*	*Estimated 1950*
100	Membership	$2,904.12	$19,703.34	$26,011.14	$27,870.55	$16,787.96	$27,200.00
300	Meetings	145.00	10,701.70	11,806.58	9,703.36	1,601.16	11,000.00
500	Exhibits	125.00	15,425.21	22,474.97	18,374.84	3,721.18	18,000.00
700	Headquarters	933.69	7,529.06	10,537.01	21,370.26	9,246.29	22,000.00
900	Administration	330.31	3,011.19	6,263.15	5,292.41	826.50	5,800.00
	Totals	$4,438.12	$56,370.50	$77,092.85	$82,611.42	$32,183.09	$84,000.00
	RECEIPTS						
200	Membership	$8,281.43	$21,477.95	$29,355.52	$35,619.17	$20,872.21	$37,800.00
400	Meetings	—	4,104.00	6,307.78	6,145.47	198.95	6,300.00
600	Exhibits	—	42,407.11*	52,838.14	55,953.04	39,094.81	50,000.00
800	Headquarters	—	—	—	—	—	—
1000	Administration	136.67	1,380.13	911.14	1,063.20	740.62	1,200.00
	Totals	$8,418.10	$69,369.19	$89,412.58	$98,780.88	$60,905.96	$95,300.00
	SURPLUSES	$3,979.98	$12,998.69	$12,319.73	$16,169.46	$28,722.87	$11,400.00

*Includes $8,342.11 net proceeds of Pittsburgh Exhibit, 1946.

UNIVERSITY OF MICHIGAN LIBRARIES

Northern California Section Installs 1950-51 Officers

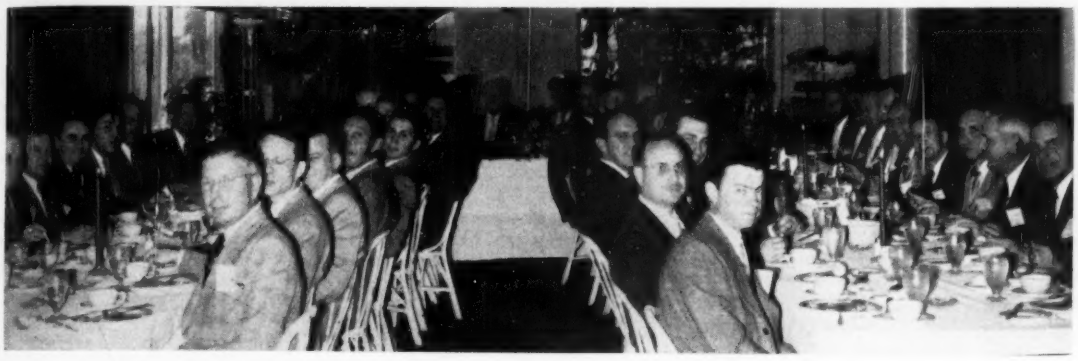
Members of the Northern California Section of ISA (chartered September 10th, 1949) convened for their annual banquet on June 19 at the Claremont Hotel in Berkeley, California.

The principal speaker was Dr. Daniel Luten of the Shell Development Company and his talk concerned post-war Japan. Dr. Luten spent over two years in occupied Japan, accumulating a collection of colored slides which he exhibited and which were accompanied by his observations on the Far Eastern situation.

The annual banquet was the occasion for transfer of Section duties to the new 1950-51 season officers who were: Walter C. Marion, new President; Peter Gibbon, new Vice President; D. J. Pompeo, National Director; Stanley D. Stillson, new Secretary; Marshal S. Caley, Chairman Membership Committee; William W. Hoover, Chairman Constitution & By-Laws Committee.

Northern California Section officers, left to right: William W. Hoover, Chairman Constitution & By-Laws Committee; Walter C. Marion, new President; Peter Gibbon, new Vice President; Marshal S. Caley, Chairman Membership Committee; Stanley D. Stillson, new Secretary; M. A. Dimmick, outgoing Secretary; Keith N. Drager, outgoing President; D. J. Pompeo, National Director.

1950 Banquet of the Northern California Section ISA.



Chicago Section Manual of Conduct

Recently there was sent to all ISA Section Directors and Section Secretaries a copy of the Chicago Section Manual of Conduct as well as a copy of the Chicago Section Constitution and By-Laws. The manual was prepared by the Rules and Procedures Committee of the Chicago Section under the Chairmanship of Mr. Earl S. Bush and a Special Committee composed of R. R. Proctor, C. C. Hurst, J. B. McMahon, and P. E. Cary.

Earl Bush gathered ideas from various individuals including past officers of the Chicago Section, all members of the Section Executive Committee, and the Special Committee mentioned above. These ideas were then correlated, revised, edited, and approved by the Chicago Section Executive Committee. Not having any previous information to work from, the Section Constitution and By-Laws served as a basic guide. Most of the new ideas presented for the manual came from R. R. Proctor and J. B. McMahon.

At the present time, distribution of the manual within the Section has been restricted to the Section officers and Committee chairmen. Eventually it will be sent to the entire Section membership in mimeographed booklet form. So far, its main use has been in explaining to new officers and committee chairmen their duties. It also has been helpful in determining the proper committee for handling new problems.

EMPLOYMENT SERVICE

Forward your letter to INSTRUMENT SOCIETY OF AMERICA, 921 Ridge Ave., Pittsburgh 12, Pa.

INSTRUMENT ENGINEER. Graduate Chemical Engr. or other with some chemical engineering training. Must be able to do some maintenance and capable of assisting in choice of flow, temperature measurement and control equipment. Must have several years experience. Position entails supervisory duties. Location Iowa. Box 322.

ELECTRICAL INSTRUMENT ENGINEER. Graduate Electrical Engr., 1950 graduate from accredited school who has had good design preparation or graduate within one or two years who has been working at design. For design of electrical indicating instruments which should include knowledge of the design of magnetic systems and coils and of the mechanical design of the components of electrical instruments. Position immediately available. Salary $4500 to $5500 depending on experience. Location Connecticut. Box 323.

INSTRUMENT ENGINEER. Mechanical Engineering graduate prefered. Must have several years experience on instrument maintenance and engineering, preferably in chemical plant or petroleum refinery. To assist in supervision of field maintenance, shop work, and new installations. Age 30 to 35. Location New Mexico. Box 324.

INDUSTRIAL INSTRUMENT ENGINEER by manufacturer of thermometers, pressure and temperature recorders, air-operated controllers and dials, mercury-vapor and liquid filled systems. Must be good draftsman with shop production ideas and experience in technical instrumentation, able to supply sales dept. with answers to application problems. Location Michigan. Box 325.

INSTRUMENT SALES ENGINEER experienced in thermometers, air-operated and self-operated controllers, recorders, and instrumentation application. Good opportunity for hard worker who can cover personally the home territory and assume direction of and increase present national agency representation program. Medium sized manufacturer. Location Detroit. Box 326.

INSTRUMENT ENGINEERS. Chemical Engineering graduates prefered. Must have two or more years in instrument work. Employer is large manufacturer of polychemicals. Location Texas. Box 327.

DEVELOPMENT SUPERVISOR. To assume the responsibilities for the development, design and evaluation of airborne antenna for military aircraft. Full knowledge of measurement techniques and 8 to 10 years of related experience required. Also several openings for junior engineers in this field. Box 328.

INSTRUMENT MAN. Thoroughly experienced, capable assuming responsibility of instrument department, for new small oil refinery in Bolivia, S. A. Opportunity for contract renewal at end of one year. Salary paid in U. S. Funds. Box 329.

INSTRUMENT REPAIRMEN. FOUR. For Gulf Coast Industry, four first class instrument repairmen with general process instrument experience in either chemical plants or petroleum refineries. Location Texas. Box 330.

Section Secretaries, Meeting Data and Programs

AKRON
Fred Appel, 932 Columbia Ct., Barberton, Ohio. Tel: SH 3440
Fourth Tuesday, Meeting at 7:30 P. M., Akron Y.W.C.A.

ALBUQUERQUE
E. J. Burda, Sandia Corp., P. O. Box 5800, Albuquerque, N. Mex.
First Monday, Meeting at 8:00 P.M., Science Lecture Hall, Univ. of N. M.

ARUBA
K. H. Walker, P. O. Box 389, c/o Lago Oil & Tranpsort Co., Ltd., Aruba, N.W.I.
First Tuesday, Meeting at 7:15 P. M., Engr's Club.

ATLANTA
H. Kockritz, Fischer & Porter Co., 84 Peachtree St., Atlanta, Ga. Tel: CY 1269
Fourth Monday, Meeting at 7:45 P.M., Ga. Institute of Technology.

BALTIMORE
W. A. Dickinson, 2716 Dunbrook Ct., Baltimore 22, Md. Tel. Chesapeake 6879
Second Friday, Meeting at 8:00 P.M., Engr's. Club of Baltimore.

BATON ROUGE
John Q. Bass, 1517 Longwood Dr., Baton Rouge, La. Tel: 3-0283
Meeting monthly, no definite time, L.S.U. Physics Bldg.

BOSTON
Stephen E. Lord, 60 Braintree Ave., Quincy 69, Mass. Tel: MA 9-1066
Last Wednesday, Dinner at 6:30 P. M., Meeting at 7:00 P.M., 99 Club.

CALIFORNIA
D. C. Duncan, Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif. Tel: SY 4-8439
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P.M., Carolina Dines.

CENTRAL ILLINOIS
Thomas A. Carroll, 721 Hurlburt St., Peoria 6, Ill. Tel.: Peoria 4-8909
First Wednesday, Dinner at 6:30 P.M., Meeting at 7:30 P.M.

CENTRAL INDIANA
Richard F. Rieman, 3550 Euclid St., Indianapolis, Ind.
First Tuesday, Meeting at 7:30 P. M.

CENTRAL NEW YORK
Karl W. Robertson, Minneapolis-Honeywell Reg. Co., 121 W. Onondaga St., Syracuse, New York.

CHARLESTON
Clayton A. Williams, 303 E. 9th St., Belle, W. Va. Tel: 927871
First Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Kanawha Hotel

CHICAGO
Floyd E. Ertsman, Rm. 1420 Fisher Bldg., 343 S. Dearborn St., Chicago, Ill. Tel: WE 9-0686
Third Tuesday, Dinner at 6:30 P. M., Meeting at 8:00 P.M.

CHINA LAKE
A. H. Staud, 1004 Michelson Lab., USNOTS, China Lake, Calif. Tel: 77882
Fourth Thursday, Meeting at 8:00 P.M., Michelson Lab, USNOTS.

CINCINNATI
Edward H. Muhleisen, 320 Durrell Ave., Cincinnati 15, Ohio. Tel: PO 1168
First Monday, Meeting at 8:00 P.M., Eng'r. Society Hqs.

CLEVELAND
A. E. Ehrke, 1732 East 291st St., Wickliffe, Ohio. Tel: WI 3-1036
Fourth Wednesday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Cleveland Eng'r. Society.

COLUMBUS
W. C. Myers, c/o Battelle Memorial Institute, 505 King Ave., Columbus, Ohio. Tel: UN 3191, Ex. 248
Third Thursday, Meeting at 8:00 P.M., Battelle Auditorium

CUMBERLAND
Clyde Babst, 225 Cecilia St., Cumberland, Md. Tel: 583-W
Tuesday after Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Algonquin Hotel.

DETROIT
Seymour Sterling, 13331 Linwood, Detroit, Mich. Tel: Tyler 5-1707
Second Wednesday, Meeting at 8:00 P.M., Rackham Bldg.

EASTERN NEW YORK
W. R. McKegg, c/o Gen. Engrg. & Consulting Lab., G. E. Co., Schenectady, N. Y.
First Tuesday, Dinner at 6:30 P.M., Meeting at 8:00 P.M.

GULF COAST
W. N. Sloan, E. I. Du Pont de Nemours & Co., Orange, Texas. Tel: 8411 Ext. 444
Third Tuesday, Meeting at 7:30 P.M., Lamar College.

HOUSTON
I. K. Farley, 2123 Travis St., Houston, Texas.
Last Monday, Meeting at 8:00 P.M., Engineers Club.

KANSAS CITY
L. E. Oberhelman, Standard Oil Co., Sugar Creek, Mo. Tel: MU 1227
First Tuesday, Meeting at 7:30 P.M., Univ. of Kansas City.

LOUISVILLE
H. C. Scherffius, 980 Palatka Rd., Louisville 8, Ky. Tel: Franklin 1265
Fourth Tuesday, Meeting at 8:00 P.M., Seagram Auditorium.

MONTREAL
S. J. Mizuhara, 1075 Allard, Verdun, Quebec, Canada. Tel: TR 3252
Last Monday, Meeting at 8:00 P.M. Mechanics' Institute.

NEW JERSEY
Fred L. Crabbe, 41 East 42nd St., New York 17, N. Y. Tel: Vanderbilt 6-2906
First Tuesday, Dinner at 6:00 P. M. Meeting at 8:00 P.M., Essex House.

NEW ORLEANS
W. H. Haney, 2927 Music Avenue, New Orleans, La.
No Regular Date, Meeting at 8:00 P.M.

NEW YORK
F. B. Leslie, 8856 Commonwealth Blvd., Bellerose 6, N. Y. Tel: FI 7-0645
Last Monday, Dinner at 6:00 P.M., Meeting at 7:45 P.M., Henry Hudson Hotel.

NIAGARA FRONTIER
Mrs. James L. Martin, 697 Potomac Ave., Buffalo 9, N. Y. Tel: GR 1450
Fourth Monday, Dinner at 6:00 P.M., Meeting at 8:00 P.M., Institute of Arts and Sciences, Buffalo.

NORTH TEXAS
R. E. Byers, 6000 Lemmon Ave., Dallas 9, Texas

NORTHERN CALIFORNIA
M. A. Dimmick, 5607 Alta Punta, El Cerrito, Calif. Tel: Be 5-1095
Third Monday, Meeting at 7:30 P.M., Angelo's, Emeryville.

NORTHERN INDIANA
J. Baum Beckman, 547 N. Waller Ave., Chicago 44, Ill. Tel: ES 8-7776
Third Wednesday, Dinner at 6:30 P.M., Meeting at 7:30 P.M., Gary Y.M.C.A.

OAK RIDGE
John H. Clark, 230 Canton Hall, Oak Ridge, Tenn. Tel: 5-9142
First Wednesday, Dinner at 6:30 P.M., Meeting at 7:30 P.M., Oak Terrace.

ONTARIO
John W. Huether, 311 Southerland Dr., Leaside, Ontario, Canada. Tel: HU-7114
Third Thursday, Meeting at 8:00 P.M. Friendship Hall, College St. United Church, Toronto

PANHANDLE
R. E. Harris, 228 Maya Bldg., Amarillo, Texas. Tel.: 31434.
Meeting at 8:00 P.M.

PHILADELPHIA
C. W. Wood, 6908 Market St., Upper Darby, Pa. Tel: Clearbrook 9-3959
Third Wednesday, Meeting at 8:00 P.M., Bellvue Stratford Hotel.

PITTSBURGH
Miss Louise Suckfield, P.O. Box 2038, Pittsburgh 30, Pa. Tel: HI 1-1800
Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Roosevelt Hotel.
Pittsburgh Inspection & Gaging Committee. Second Tuesday, Meeting at 8:00 P.M., Wm. Penn Hotel. Tel: CE 1-5621

PRESQUE ISLE
Edwin P. Schuwerk, 445½ Halley St., L. P., Erie, Pa. Tel: 2-3349
Fourth Tuesday, Meeting at 8:00 P.M., G. E. Community Center, East Lake Rd.

RICHLAND
R. A. Nederhood, 2003 Trippe, Richland, Washington. Tel. 5-4442
Second Wednesday, Meeting at 7:30 P.M., American Legion Hall.

ROCHESTER
R. C. Schwarz, Jr., 1201 Granite Bldg., Rochester 4, N. Y. Tel: Monroe 4610R
Fourth Tuesday, Meeting at 8:00 P.M., Univ. of Rochester, Physics Lecture Hall.

SARNIA
J. J. Connors, 272 Elvin St., Sarnia, Ontario, Canada. Tel: 1970 W
Second Friday, Meeting at 8:00 P.M., Moose Hall.

SOUTH BEND
Sam M. Rouse, 436 Moccasin Ave., Buchanan, Mich. Tel: 678
First Thursday, Meeting at 8:00 P.M., Engineers Club, Hotel La Salle, South Bend.

SOUTH MICHIGAN
Larry DeHaan, 1117 Cobb Ave., Kalamazoo, Mich. Tel: 2-0385
Fourth Wednesday, Dinner at 6:30 P.M. Meeting at 8:00 P.M., Chicken Charlie's, Kalamazoo.

SOUTH TEXAS
H. C. Givens, La Gloria Corp., P.O. 687, Falfurrias, Texas. Tel: 122-W
First Thursday. Meeting at 7:30 P.M., Garner Aircraft Instrument School.

ST. LOUIS
W. G. Lee, 4710 Delor St., St. Louis 16, Mo. Tel: FL 8516
First Wednesday, Meeting at 8:00 P.M., Engineer's Club of St. Louis.

TOLEDO
Morris L. Conner, 925½ Sherman St., Toledo, Ohio. Tel: MA 9403
Third Tuesday, Meeting at 8:00 P. M., Service Bldg., Toledo Edison Co.

TENNESSEE
N. M. Taylor, 16 Edgewood, Kingsport, Tenn. Tel: 3338J
No definite night, Dinner at 6:45 P.M., Meeting at 8:00 P.M., Hall's Dining Rm., Bristol Hwy.

TULSA
J. J. Fox, Phillips Petroleum Co., Phillips Bldg., Bartlesville, Okla.
First Monday, Meeting at 6:45 P.M., Engineering Bldg., Tulsa Univ.

TWIN CITIES
Alden Hine, c/o Giesika & Pinkney, 552 Plymouth Bldg., 6th & Hennepin Ave., Minneapolis 2, Minn. Tel: Whittier 6420
Fourth Tuesday, Dinner at 6:30 P.M. Coffman Memorial Union, U. of Minn.

WASHINGTON
Raymond E. Miller, 20-224 Naval Ord. Lab. White Oak, Md. Tel: JU 7-6742
Third Monday, Meeting at 8:00 P.M., P. E. P. Co. Auditorium.

WAYNE COUNTY
Robert Karr, 2455 Biddle Ave., Wyandotte, Michigan. Tel. 0167J
Third Monday, Snack after meeting, Larson's Cafe.

WILMINGTON
Dean Valentine, 34 N. Hill Drive, West Chester, Pa. Tel: 0293W
Third Tuesday, Meeting at 8:00 P.M. Harlan Public School, Wilm.

Calcuttan Joins Akron Section

The Akron Section ISA has accepted for membership, Mr. Indra N. Das, whose permanent address is Calcutta, India. Mr. Das has been in the United States since February, 1950. He is studying the manufacture, installation, and maintenance of instruments and controls which are to be installed in the Bokaro Steam Plant of Damodar Valley Corporation, an organization in India similar to our TVA.

Das is a graduate of the University of Calcutta and holds a degree in electrical engineering. Before the war he spent several years in England where he was associated with the Chemical Construction Corporation. Later he held various jobs in both England and India before being selected for the position of Instrument Engineer for Damodar Valley Corp.

UNIVERSITY OF MICHIGAN LIBRARIES

JOURNAL of the
Southern California Meter Association

President: James E. Adams — Auditor: Robert D. Pomeroy
Vice-President: H. C. Bennett — Past President: R. Frank Fields
Secretary-Treasurer: George H. Forster, 2916 Eucalyptus Ave., Long Beach 6, Calif.

Sight Reading of Orifice Meter Charts

By HARRY A. FAULL, Southern Counties Gas Co.*

IN THE preceding lecture, Mr. Forster left the orifice meter equation in the form

$$Q = C' \sqrt{}(hP_2)$$

where Q = rate of flow, standard cubic feet/hour
C = corrected natural gas hourly coefficient
h = pressure loss, inches of water
P_2 = absolute downstream pressure, psi.

It will be noted that Q is a *rate* and not an integrated quantity. That is, an instantaneous set of values measured by an orifice meter tells no more than does the speed indicator on an automobile speedometer. To measure gas volumes as such, with an orifice meter, time must be taken in as a factor. The unit of time is usually the hour: C′ is an *hourly* coefficient, and the radical expression $\sqrt{}(hP_2)$ commonly called the "extension," is for average hourly values of h and P_2. So, to compute the volume represented by an orifice meter chart record of 24 hours rotation, the equation

$$V_{24} = C'\sqrt{}(hP_{2(1)}) + C'\sqrt{}(hP_{2(2)}) + C'\sqrt{}(hP_{2(24)})$$

is used. This may be written

$$V_{24} = C' \times \sum_0^{24} \sqrt{}(hP_2)$$

where V_{24} = volume for a 24-hour period, cubic feet;
C′ = as before;

$$\sum_0^{24} \sqrt{}(hP_2)$$

= the sum of the 24 hourly extension.

M Chart

C′ has been evaluated, the differential gage has measured and recorded h and P (gage pressure); so we may proceed now with the computation of the volume.

The first case considered will be the M chart. The most common procedure is to determine average hourly values of h and P (which may be written on the chart, or on a form provided for the purpose) and, by reference to a book of Pressure Extensions, find the extension corresponding to these values of h and P. This Pressure Extension book is simply a tabulation of extension values $\sqrt{}(hP_2)$ for a wide range of h and P values. These hourly extensions are then summarized and multiplied by the corrected hourly coefficient and the result is the quantity passed by the meter in the time interval represented by the chart. The extension may be determined by adding the value of atmospheric pressure at the meter site to the recorded pressure, P, multiplying the sum by h, and taking the square root of the product. When using a Pressure Extension book, it should be kept in mind that some average atmospheric pressure was used in its compilation, and that at lower values of P_2, appreciable error will be incurred if the atmospheric pressure at the meter site is much different from that on which the Pressure Extension book is based.

An important point to keep in mind when figuring charts, is that the quantity flowing varies as the square root of h and as the square root of P_2, and that the square root of the *average* value of h (or P_2) is not equal to the average of instantaneous square roots of h (or P_2). Failure to take cognizance of this fact will result in serious error if h or P_2 vary widely. The following example, possibly somewhat exaggerated, will illustrate. The differential record for a certain hour, is 49 in. for the first 15-minute period, 36 in. for the second 15-minute period, 16 in. for the third 15-minute period, and 4 in. for the fourth 15-minute period (assume the pressure remains constant). The average of all these h values is

$$\frac{49+36+16+4}{4} = 26.25,$$

and $\sqrt{}26.25 = 5.12$. The average of the values of $\sqrt{}h$ is

$$\frac{7+6+4+2}{4} = 4.75,$$

and the percentage error caused by taking the square root of the average h instead of taking the average of the square roots of h is

$$\frac{5.12-4.75}{4.75} \times 100 = 7.8 \text{ percent.}$$

If the differential varies widely in an hour, the usual procedure is to determine extensions for 15-minute intervals, then average the extensions and add the average hourly extension into the total extension. The same applies to a wide variation in pressure, but wide variations in differential are much more common.

Square Root, or L-10, Chart

A differential reading on an L-10 chart represents, not the value of h, but the value of $\sqrt{}h$, when the chart is on a 100 in. gage, and, on any other range gage, the differential record is the square root of some constant fraction, or multiple of h. When L-10 charts are used, the pressure-pen arm is set up to indicate atmospheric pressure at the meter site, when the gage pressure is zero, and then all pressure readings on an L-10 chart on a 0 to 100 psi. gage are $\sqrt{}P_2$ instead of the first power of the gage pressure recorded on M charts. For any other range spring, the pressure readings are the square root of some constant fraction, or multiple, of P_2. The fractions, or multiples, referred to above are equal to 100 divided by the maximum range of the gage. For instance, an M chart reading of 32 in. on a 0-50 in. differential gage would correspond to a reading on an L-10 chart of $\sqrt{}[32 \times (100/50)] = 8.0$. And an M chart reading of 146 psi. gage (assuming atmospheric pressure = 14 psi., then 146 psi. gage = 160 psi. absolute) on a 0-250 psi. pressure gage would correspond to a reading on an L-10 chart of $\sqrt{}[160 \times (100/250)] = 8.0$.

Suppose we are measuring gas with a 50 in. differential gage fitted with a 100 psi. spring, and using an L-10 chart. Then $\sqrt{}(R_h/100) \times \sqrt{}(R_p/100) = \sqrt{}(50/100) \times \sqrt{}(100/100) = 0.7071$, and

October Meeting: Thursday the 19th, Rio Hondo Country Club, Downey, Calif. Dinner at 6:30, meeting at 8:00 p.m.

Features: (1) Operation of Multi-element Controls, by Howard Anderson, Instrument Foreman, So. Calif. Edison Co.; (2) SCMA Meter Course.

—Louis J. Delaney
Publicity Chairman

*Read by F. M. Partridge at regular meeting of the Southern California Meter Association, July 20, 1950.

the quantity flowing per hour is $Q = C' \times 0.7071 \times h_s P_{s2}$. The value of the M factor for any orifice meter gage is usually written

$$M = 0.01 \times \sqrt{(R_h R_p)}$$

where R_h = maximum differential range of the gage,

and R_p = maximum pressure range of the gage.

We see that by the use of an L-10 chart we have changed the equation $Q = C' \sqrt{(hP_2)}$ to an equation where all the factors are to the first power, and to that extent, we have simplified the calculation of the volume flowing per hour. The M factor is multiplied into the corrected coefficient and the calculation of quantity flowing per hour simply involves multiplying together three factors ($C'_s \times h_s \times P_{s2}$: where $C'_s = C' \times M$). To compute the quantity passed in 24 hours, the average hourly values of h_s and P_{s2} are determined; by reference to tables or by computation. The hourly extensions are evaluated, summarized, and their sum multiplied by the coefficient C'_s. The extension in the case of the square root chart is simply the product of h_s and P_{s2}.

Table I lists the value of h_s and P_{s2} as read from the square root chart mentioned, the extension values, and their sum.

TABLE I

A. M.	h_s	P_{s2}	Extension	P. M.	h_s	P_{s2}	Extension
12- 1	5.54	6.94	38.45	12- 1	5.65	6.76	38.1
1- 2	5.75	6.99	40.19	1- 2	5.58	6.71	37.4
2- 3	5.42	7.02	38.05	2- 3	5.60	6.68	37.4
3- 4	5.18	6.98	36.16	3- 4	5.33	6.71	35.7
4- 5	5.50	6.79	37.34	4- 5	5.57	6.68	37.2
5- 6	5.53	6.88	38.05	5- 6	5.64	6.55	36.9
6- 7	5.44	7.02	38.19	6- 7	5.65	6.34	35.8
7- 8	5.42	6.86	37.18	7- 8	5.59	6.34	35.4
8- 9	5.38	6.52	35.08	8- 9	5.68	6.51	36.9
9-10	5.40	6.62	35.75	9-10	5.55	6.57	36.4
10-11	5.50	6.69	36.80	10-11	5.35	6.63	35.4
11-12	5.60	6.69	37.46	11-12	5.34	6.79	36.2
			448.7				439.4
							448.7

Total Extension 888.1

TECHNICAL SOCIETIES

National Conference on Industrial Hydraulics

CHICAGO—The tentative program for the sixth annual National Conference on Industrial Hydraulics, Oct. 18 and 19 at the Sherman hotel in Chicago, was announced by the conference secretary, Frank W. Edwards, chairman of the civil engineering department at Illinois Institute of Technology.

Sponsors of the non-profit, non-commercial technical conference are the Armour Research Foundation of Illinois Institute of Technology and the Graduate School of the Institute, with the cooperation of seven technical societies: American Society of Civil Engineers, American Society of Mechanical Engineers, Society of Automotive Engineers, Western Society of Engineers, American Society of Lubricating Engineers, American Institute of Chemical Engineers, and the Institute of Aeronautical Sciences.

Wednesday Morning, October 18, GENERAL SESSION—Hydraulic Control Problems in Automatic Transmissions, by R. L. Smirl, Borg and Beck Division, Borg Warner Corp. Operation and Care of Hydraulic Machinery, by J. C. Van Gundy, The Texas Co.

Wednesday Afternoon, October 18, AERONAUTICAL HYDRAULICS—Aircraft Hydraulic Equipment Problems, by Carl W. Chambers, Douglas Aircraft Co. Cavitation in Piston and Gear Type Pumps, by R. J. S. Pigott, Gulf Research and Development Co.

CENTRIFUGAL PUMPS—Volute vs Diffusion Casing for Centrifugal Pumps, by A. J. Stepanoff, Ingersoll-Rand Co. SPECIAL FLUID PROBLEMS—Effect of Rate of Shear on Viscosity, by Sydney J. Needs, Kingsbury Machine Works. Fluidynamics of Rubble Trays, by Glen S. Houghland and Warren C. Schreiner, M. W. Kellogg Co.

Thursday Morning, October 19, HYDRAULIC PRESSES—Accumulator versus Self-Contained Pumping Unit, by J. J. Littley. Large Hydraulic Presses in Germany before and during World War II, by A. Zeitlin, Hydropress, Inc.

CIVIL ENGINEERING HYDRAULICS—Hydraulic Dredging, by J. E. Yager, Bucyrus Erie Co. Large Sewage Pumps, by H. T. Sward, Fairbanks Morse and Co. Operating Experiences with High-Head Gates and Valves, by W. G. Weber, Bureau of Reclamation.

HOSE AND FITTINGS—Hose Assemblies and Related Fittings, by Don Stranberg, Anchor Coupling Company, Inc. "O" and "V" Rings, by J. H. Swartz, Linear, Inc.

Thursday Afternoon, October 19, AGRICULTURAL HYDRAULICS—Utility of Hydraulic Power in Farming with Wheel-Type Tractors, by J. F. Ziskal, International Harvester Co. Utility of Hydraulic Power in Farming with Track-Laying Type Tractors, by F. P. Hanson, Caterpillar Tractor Co.

REFINERY HYDRAULICS—New Developments in Reciprocating Pumps, by E. F. Wright, Worthington Pump & Machinery Corp. Application of Centrifugal Pumps, by A. E. Harnsberger, Pure Oil Co.

CONTROL OF SURGES—The Desurger, by John Howard Dawson, Oklahoma A. and M. College. Mechanical-Pneumatic Shokstops—Their Place in Relief of Liquid Hammer, by L. H. Kessler, Northwestern Technological Institute.

Fifth Annual Symposium on "Instrumentation for the Process Industries"

Houston, Texas.—The Agricultural and Mechanical College of Texas, at College Station, Texas, will offer their fifth symposium on "Instrumentation for the Process Industries," on October 11, 12 and 13, 1950. The course will be conducted as a seminar with lectures and discussions on the subject of automatic control. Cooperating with Texas A & M in the presentation of this course will be many industrial concerns manufacturing oil, gas, and chemical products. Manufacturers of measuring instruments and automatic controllers, likewise, are taking part by arranging to show educational exhibits, and provide capable lecturers for many of the sessions.

The program will cover a wide variety of subjects making it of value to anyone who uses such instruments, especially to instrument, process design and operating engineers. Problems of instrument maintenance will not be covered specifically in the lectures, but ample opportunity for the consideration of such problems will be provided in the discussion periods. The lectures will cover the subjects of measurement and control of temperature, pressure and liquid level, time control, and other allied subjects. The relationship between practice and basic control theory will be stressed.

Anyone living either in or outside Texas is eligible to take this course on payment of the $5.00 registration fee; pre-registration by mail is encouraged. Rooming accommodations and meals will be available on the campus at the college dormitories and mess hall at a reasonable price. An evening banquet and entertainment are also planned.

Further information may be obtained by writing Professor P. G. Murdock, Chemical Engineering Department, Texas A & M College, College Station, Texas.

Society for Applied Spectroscopy

The October meeting of the Society for Applied Spectroscopy will be held Tuesday the 3rd. 6:00 p.m.—Informal Dinner—Tosca's, 118 Fulton Street, New York—No Reservation necessary. 8:00 p.m.—Regular meeting—Socony-Vacuum Training Center—63 Park Row, New York. Speaker, Dr. Bruce Billings, Baird Associates, Inc.; subject—Right and Left in Optics.

—CHARLES H. NORTH, *Publicity Chairman, National Lead Co., Titanium Div. P. O. Box 58, South Amboy, N. J.*

Conference On Automatic Control -- 1951

LONDON, ENGLAND.—A conference on Automatic Control is to be held at the College of Aeronautics, Cranfield, Bedfordshire, in the summer of 1951. (Monday 16th to Saturday 21st July, 1951). The papers and discussions should be of particular interest to engineers, physicists, and mathematicians concerned with the theory, design, production, and testing of automatic control systems, and their use in industry. They will cover the following main topics:—

Automatic Control Systems: General Theory and problems of Synthesis.

Servo Control Systems: Non Linearities.

Process Control, including inter-relation with Servo Control.

The Human Operator.

Other more specialized topics may be included, and there will also be provision for a limited display of apparatus having a special bearing on the subject of the Conference.

The Conference is being sponsored by the Department of Scientific and Industrial Research, and the Organizing Committee is under the Chairmanship of Professor A. Tustin, professor of Electrical Engineering at the University of Birmingham.

The accommodation at Cranfield is limited to about 250, and it will be necessary to limit attendance to leading workers in the field of automatic control.

Papers eventually selected for presentation will be required in their final form not later than the 1st January, 1951, and only in exceptional circumstances will papers in excess of 5,000 words be accepted.

Additional information may be obtained from the Secretary of the Organizing Committee, Conference on Automatic Control—1951, Department of Scientific and Industrial Research, Charles House, Regent Street, London, S.W.1, England.

UNIVERSITY OF MICHIGAN LIBRARIES

A SUPERIOR DETECTOR for INFRA-RED SPECTROSCOPY

Golay

PNEUMATIC DETECTOR

Among the characteristics that render the Golay Detector superior to other types of detectors for use in infra-red spectroscopy are:

1. An effective sensitive area 3/32" in diameter.
2. Sensitivity of 6 x 10-11 watts RMSENI when used with "chopped beam" method and with recording time constant of 1.6 second.
3. Uniform sensitivity from the ultra-violet through the visible and the entire infra-red, and up to the micro-wave region.

Write for EPLAB Bulletin No. 10

THE EPPLEY LABORATORY, INC.

Scientific Instruments

NEWPORT • RHODE ISLAND • U. S. A.

ELEMENTARY ENGINEERING ELECTRONICS

With Special Reference to Measurement and Control

By ANDREW W. KRAMER

Managing Editor *Power Plant Engineering*, Member American Institute of Electrical Engineers, Associate Member Institute of Radio Engineers.

Cloth, 344 pages, 259 illustrations, $2 postpaid

This is a PRACTICAL treatment of principles and applications. It is NON-MATHEMATICAL—no equations beyond elementary-algebra level in the text—fewer than a dozen of these to be learned.

Acquire a better knowledge of electronics without trying to be a radio engineer.

ORDER THIS UNIQUE BOOK NOW

Check, money order or cash must accompany order

The Instruments Publishing Co., Inc.
921 Ridge Ave. Pittsburgh 12, Pa.

Precise

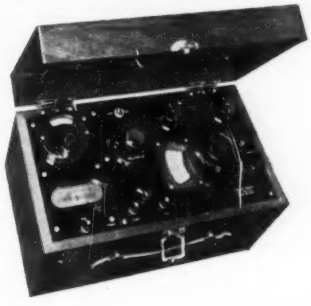
TEMPERATURE MEASUREMENTS

. . . with the Rubicon
MUELLER BRIDGE

A highly accurate and specialized form of the Wheatstone bridge designed expressly for precise resistance thermometry with three- or four-lead thermometers and for the measurement of other similar resistors within its range.

- Wide range: 0 to 71.1110 ohms in increments of 0.0001 ohm
- Unity ratio with provision for convenient checking and precise adjustment of ratio arms
- Built-in mercury commutator for lead resistance compensation
- Sub-panel switch construction
- Built-in plug and block assembly for conveniently checking ratio, bridge zero and thermometer resistance with no disturbance of external bridge connections

Described in Bulletin 100



. . . with the Rubicon
PORTABLE PRECISION POTENTIOMETER

A two-dial instrument of exceptional accuracy and sensitivity.

- High-sensitivity, sturdy, built-in Pointerlite galvanometer—permits balancing to within 2 microvolts in low resistance circuits
- Completely self-contained assembly—no external accessories except the thermocouple circuit
- Two ranges —0 to 16.1 and 0 to 161 millivolts—readable to within 2 and 20 microvolts respectively
- Sturdy, compact construction for long dependable service

Described in Bulletin 270

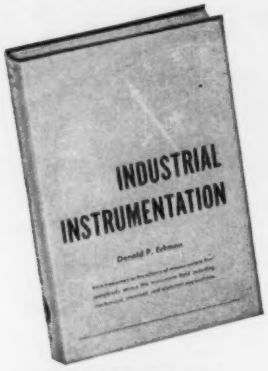
RUBICON COMPANY

Electrical Instrument Makers

3755 Ridge Avenue • Philadelphia 32, Pa.

Just Published

Banish trial-and-error . . .
Analyze your way to better



INDUSTRIAL INSTRUMENTATION

By DONALD P. ECKMAN,
Cornell University;
Consulting Engineer, Conoflow Corporation

This new book organizes the science of measurement on its own physical and chemical basis. Principles, analysis, operation, and applications of measurement are covered for temperature, pressure, rate-of-flow, and composition.

7 Outstanding Features

- Treats thoroughly all process instruments. No supplementary books or other sources required.
- Includes a chapter on Composition Analysis Methods and Instruments, covering emission and absorption spectroscopic analysis, mass spectrographic analysis, and other important methods.
- A chapter on METHODS OF APPLYING INSTRUMENTATION TO PROCESSES shows the arrangement and selection of instruments and controllers, process analysis, and supervision of instrument equipment.
- A section is devoted to HIGH VACUUM INSTRUMENTATION.
- A chapter covers INSTRUMENTS FOR MECHANICAL MEASUREMENTS such as displacement gages, strain gages, force meters, velocimeters, and accelerometers.
- 247 illustrations of operation principles and meter installations, response curves, etc.
- 23 tables in the appendix. These include Fahrenheit-Centigrade conversion tables, standard thermocouple emf tables, orifice flow coefficient tables, and other data important to instrumentation analysis.

June 1950 396 pages $5.00

EXAMINE BOOK FOR 10 DAYS

ON APPROVAL COUPON

John Wiley & Sons, Inc., Dept. I-9-50
440 Fourth Ave., New York 16, N. Y.
Please send me, on 10 days' approval, a copy of Eckman's INDUSTRIAL INSTRUMENTATION. If I decide to keep the book, I will remit $5.00 plus postage; otherwise I will return the book postpaid.

Name .....
Address .....
City .....Zone.....State.....
Employed by .....
(Offer not valid outside U.S.)

Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 863.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

S-535 SEALED THERMOSTATS. 4-page bulletin describes and illustrates maker's s-p. s-t. temperature-operated hermetically-sealed electric switches; covers advantages, specifications, applications, and features of various types.—Instrument Div., Thomas A. Edison, Inc., West Orange, N. J.

S-536 CERAMIC CATALOG. 12-page catalog describes maker's high-temperature ceramic shapes; covers dimensions, capacities, prices, and other data on recrystallized alumina, mullite sillimanite, magnesia, fused magnesia, zirconia, fused alumina and thoria shapes.—Laboratory Equipment Corp., St. Joseph, Mich.

S-537 BUFFER SOLUTIONS. 4-page circular describes maker's buffer solutions for standardizing pH measuring equipment; covers features, prices.—Leeds & Northrup Co., 4908 Stenton Ave., Philadelphia 44, Penna.

S-538 PHOTOELECTRIC AMPLIFIERS. 8-page Catalog 550 illustrates and describes maker's line of photoelectric equipment and accesories for industrial applications; covers features, specifications; typical uses.—Dep't. C, De-Tec-Tronic Labs, Inc., 1227 N. Clark St., Chicago 10, Ill.

S-539 INDUSTRIAL THERMOCOUPLES. 8-page Catalog Section 22 describes and illustrates maker's industrial thermocouples for all pyrometers; covers features, specifications on tubular thermocouples and protection tube assemblies, wire type protected assemblies, portable pouring type for molten metals, etc.—Thermo Electric Co., Inc., Fair Lawn, N. J.

S-540 SMOKE INDICATORS. 8-page Bulletin 501 illustrates and describes maker's "Electric Eye" smoke and combustion instruments; covers features, characteristics of indicators, and potentiometer and operation recorders.—Ess Instrument Co., Bergenfield, N. J.

S-541 THERMOMETERS. 44-page Catalog 200-G describes and illustrates maker's red-reading-mercury industrial thermometers; covers construction, ordering information, features, ranges of various types (separable socket, union connection, union flange, fixed taper thread, parallel thread and locknut); also covers dial and recording thermometers.—Palmer Thermometers, Inc., 2501 Norwood Ave., Cincinnati 12, Ohio.

S-542 DIAL THERMOMETERS. 4-page bulletin illustrates and describes maker's mercury-actuated dial thermometer with adjustable stem and case to fit any angle or position; covers specifications, engineering and ordering data.—Palmer Thermometers, Inc., 2501 Norwood Ave., Cincinnati 12, Ohio.

S-543 PYROMETERS. Four bulletins illustrate and describe maker's "Sim-ply-trol" contact meter-relay type pyrometers, voltmeters, milliammeters, etc.; cover features, specifications, ranges for each model.—Assembly Products, Inc., Chagrin Falls, Ohio.

S-544 CORROSION TEST CABINETS. Revised catalog page illustrates and describes maker's test cabinets for accelerated testing of corrosion-resisting qualities of coatings on metal products; covers uses, features.—Industrial Filter & Pump Mfg. Co., 5900 Ogden Ave., Chicago 50, Ill.

S-545 STEP MOTORS. 4-page bulletin illustrates and describes maker's d-c. step motors for transmitting both data and torque; covers features, specifications; contains outline drawings.—Arma Corp., 254 36th St., Brooklyn 32, N. Y.

S-546 BROAD-BAND D-C. AMPLIFIER. 2-page bulletin describes and illustrates maker's "Model 36B" broad-band d-c. amplifier; covers features, quantitive data on performance, applications.—Electro-Mechanical Research, Inc., Ridgefield, Conn.

S-547 MILL GAGES. 16-page Bulletin 489 describes and illustrates maker's "Electrolimit" mill gages ("Model D" continuous gage and control unit, pressure block gage, foil gage, etc.); covers features; includes operation, construction information.—Pratt & Whitney, Div. Niles-Bement-Pond Co., West Hartford 1, Conn.

S-548 TIMER-OPERATED GAS VALVE. 4-page bulletin describes and illustrates maker's "Time-O-Gas" timer-operated gas valve; covers specifications, features, mounting, installation, applications.—Erie Mfg. Co., 300 N. 8th St., Milwaukee 3, Wis.

S-549 DRAWING EQUIPMENT. 32-page Catalog A illustrates and describes maker's drawing sets and instruments, planimeters, slide rules, triangular and flat type scales, T-squares, curves and other drafting equipment.—Berger Scientific Supplies, Inc., 342 Madison Ave., New York 17, N. Y.

S-550 DIAL GROOVE GAGE. 2-page bulletin describes and illustrates maker's dial groove gage for checking internal groove diameters; covers engineering data and specifications.—Nilsson Gage Co., Inc., Poughkeepsie, N. Y.

S-551 D-C. MILLIVOLTMETER. 2-page bulletin illustrates and describes maker's "Model MV-17B" d-c. vacuum-tube millivoltmeter; covers features, applications and specifications; also describes maker's d-c. micromicroammeter, covering features, specifications.—Millivac Instruments, P. O. Box 3027, New Haven, Conn.

S-552 CORE HARDNESS TESTER. 2-page bulletin describes and illustrates maker's core hardness tester; covers features, operation; contains table of core hardness numbers.—Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.

S-553 EXPOSURE PHOTOMETER. 6-page folder describes and pictures maker's "SEI" exposure photometer; covers features, uses.—The Zoomar Corp., 381 Fourth Ave., New York 16, N. Y.

Manufacturers' representative covering Texas, and the Great West desires additional industrial lines for all or part of the mentioned territory.

Member of the Diesel Engineers International Association and member of the Instrument Society of America.

GEORGE A. KRUTILEK

P.O. Box 227; El Paso, Texas

UNIVERSITY OF MICHIGAN LIBRARIES

S-554 PERMEABILITY TESTER. 2-page bulletin illustrates and describes maker's "Permtester" for determining permeability of foundry sands and cores; covers construction, operation, dimensions and accessories.—Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.

S-555 HERMETICALLY-SEALED CONNECTORS. 2-page bulletin GS-2 illustrates and describes maker's "Type GS" hermetically-sealed connectors; covers uses, specifications, assemblies available.—Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif.

S-556 CONTINUOUS VISCOSIMETER. 4-page Catalog Section 88 describes and illustrates maker's "Viscorator" continuous viscosimeter (0.0008 to 800,000 centipoises); covers features, operation, capacities and dimensions; encloses 2-page bulletin "Continuous Measurement and Control of Nylon Size Viscosity."—Fischer & Porter Co., Hatboro, Penna.

S-557 AMPLIFIER TESTER. 6-page folder pictures and describes maker's "Dynamic Micro-Miker" amplifier tester; covers features, uses, specifications.—Kalbfell Labs, Inc., 1076 Morena Blvd., San Diego 10, Calif.

S-558 POTENTIOMETER CONTROLLERS. 2-page bulletin PO-1 describes and illustrates maker's "Potentiotrol" potentiometer controllers; covers features, operation, specifications, and ordering information.—Wheelco Instruments Co., Chicago 7, Ill.

S-559 ELECTRONIC TIMER. 4-page bulletin illustrates and describes maker's "CR 7504" electronic timer; covers features, ranges, typical applications, operation, and construction.—Apparatus Dep't, General Electric Co., Schenectady, N. Y.

S-560 DIMMERS. 16-page bulletin 76 describes and illustrates maker's "Radiastat" and "Autrastat" dimmers for lighting control; covers features, construction, operation, sizes and capacities, typical mounting frameworks, installation and maintenance, and typical specifications.—Ward Leonard Electric Co., Mount Vernon, N. Y.

S-561 TEMPERATURE REGULATORS. 2-page bulletin 50 describes and pictures maker's temperature regulators; covers features, types, general specifications, principles of operation, construction.—Farris Stacon Corp., 436 Commercial Ave., Palisades Park, N. J.

S-562 D-C. MILLIVOLTMETER. 4-page bulletin illustrates and describes maker's "Model MV-18B" r-f. VTVM&d-c. millivoltmeter for TV, FM and radar; covers features, applications, operation data specifications.—Millivac Instruments, P. O. Box 3027, New Haven, Conn.

S-563 ELECTRON TUBES. Two 4-page "Application Note" bulletins cover factors to be considered in use of maker's kinescopes. AN-144 covers "Component Considerations and Centering Adjustments for Kinescope 16GP4"; and AN-145 "Modifying a Horizontal Blocking Oscillator to Provide Increased Driving Voltage for the Scanning Circuit."—Tube Dep't, Radio Corp. of America, Harrison, N. J.

S-564 "MEASUREMENTS NOTES." 4-page No. 2 issue of this house organ features article titled "Measurement of Receiver Impulse Noise Susceptibility."—Measurements Corp., Boonton, N. J.

S-565—GAGING SCREENS FOR OPTICAL COMPARISON. 4-page bulletin illustrates and describes maker's "Micro-gage" screens for making and repeating optical comparator measurements; covers features and operation of standard and custom-made screens; also illustrates and describes maker's fixture bases for simplified mounting of holding fixtures.—Engineers Specialties Div., 980 Ellicott St., Buffalo 9, N. Y.

S-566 PINCH-TYPE VALVES. 16-page Bulletin 455 describes and illustrates maker's line of natural and synthetic rubber pinch-type valves; covers uses, advantages, and specifications on valves for fluid service, slip-on, flanged, and diaphragm-motor types; includes charts on flow characteristics and capacities.—The Flexible Valve Corp., 610 Commercial Ave., Palisades Park, N. J.

S-567 TRANSFORMERS, REACTORS, FILTERS. 28-page catalog illustrates and describes complete line of maker's transformers, reactors and filters; covers applications, specifications, amplifier circuits, curves and charts; includes index and price list.—United Transformer Co., 150 Varick St., New York 13, N. Y.

S-568 ACCELEROMETERS. Two 2-page bulletins, No. 4.1 superseding 401-A and No. 4.2 superseding 402 describe and illustrate several of maker's accelerometers. No. 4.1 includes specifications, selection table and price of maker's "Model C." No. 4.2 includes similar data on "Models A5A, A8, and SA."—Statham Labs, Inc., 9328 Santa Monica Blvd., Beverly Hills, Calif.

S-569 CALIBRATING RESISTORS. 2-page Bulletin 600 describes and illustrates (transducer circuit schematic) use of maker's calibrating resistors to standardize apparatus involving maker's transducers; lists price.—Statham Labs, Inc., 9328 Santa Monica Blvd., Beverly Hills, Calif.

S-570 BOILER FEEDWATER CONTROL. 8-page Bulletin S-52 describes and illustrates maker's one-, two- and three-element boiler feedwater control system; covers features and advantages of each.—Republic Flow Meters Co., 2240 Diversey Pkwy., Chicago 47, Ill.

S-571 POWER SUPPLIES. 4-page bulletin illustrates and describes maker's electronically regulated power supplies; covers characteristics, size of each model.—Furst Electronics, 12 S. Jefferson St., Chicago 6, Ill.

S-572 MAGNETIC VALVES. 16-page loose-leaf booklet illustrates and describes several models of maker's magnetic valves for flow control (normally open, normally closed, full port normally open, etc.); covers application, construction, operation, specifications of each.—Magnatrol Valve Corp., 67 Fifth Ave., Hawthorne, N. J.

S-573 METAL INSPECTION BY DYE PENETRATION. 6-page folder describes dye penetrant method of metal inspection with maker's solutions; gives complete instructions for use.—Dy-Chek Co., Div., Northrop Aircraft, Inc., 1515 East Broadway, Hawthorne, Calif.

S-574 SHOCK MACHINE. 8-page Bulletin 601A describes and pictures maker's "Type 150 VD" medium impact shock machine; covers features, construction, rating and dimension data; includes characteristic curves on range and deceleration pulse.—The Barry Corp., 173 Sidney St., Cambridge 39, Mass.

S-575 SWITCHES. 24-page bulletin describes and illustrates maker's snap-action switches with "rolling spring" construction; covers principle of operation, operating characteristics, features of several models; also includes 4-page price list and discount schedule.—Acro Switch Div., The Acro Mfg. Co., 2040 E. Main St., Columbus, Ohio.

S-576 "THE GENERAL RADIO EXPERIMENTER." 8-page Vol. 25, No. 2 issue of this house organ features article titled "A Bolometer Bridge for the Measurement of Power at High Frequencies"; lists specifications for maker's "Type 1651-A" bolometer bridge.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

S-577 "hp JOURNAL." 4-page Vol. 1, No. 11 issue of this house organ features article on maker's "Model 460B" 125-volt fast pulse amplifier; covers specifications, accessories.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

S-578 INSULATION BREAKDOWN TESTERS. 4-page Bulletin 5A illustrates and describes maker's "Series 500" mobile and "Series 570" semi-portable high potential insulation breakdown testers; covers features, operation, specifications.—Associated Research, Inc., 3758 W. Belmont Ave., Chicago 18, Ill.

S-579 ABRASION TESTING SET. 6-page Bulletin 5003 describes and illustrates maker's "Model 140" standard abrasion testing set; covers features, applications.—Taber Instrument Corp., 111 Goundry St., North Tonawanda, N. Y.

S-580 VARIABLE TRANSFORMERS. 16-page Bulletin P550 describes and illustrates complete line of maker's standard "Powerstat" variable transformers; also covers maker's line correctors, oil-cooled and explosion-proof models, and "Voltbox" a-c. power supplies; includes features, specifications, performance curves, charts; back cover contains complete rating

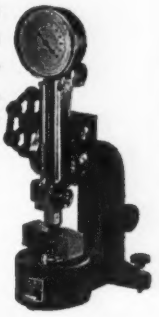
HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 42 years.

In general use for specification purposes. Simple, sturdy. Comparatively inexpensive.

•

Illustrated bulletins free



The Shore Instrument & Mfg. Co., Inc.

90-35 Van Wyck Expressway
Jamaica 2, N. Y.

High Precision OPTICAL COMPONENTS Any Size For Astronomical and Physical Research

•

Parabolic, Spherical, Ellipsoidal and Plane MIRRORS

•

Plane Parallel PLATES

•

SCHLIEREN SYSTEMS

•

Interferometer PLATES

•

LENSES and PRISMS of Glass

•

Natural or Synthetic CRYSTALS

•

Complete Optical and Mechanical INSTRUMENTS

•

Made to Specifications

•

High Vacuum Coating

•

John Unertl Optical Co.

3551-3555 East Street
Pittsburgh 14, Penna.

NEW REFINERY ACRAGAGE

Removing Waterproof Blowout Disc exposes entire mechanism for inspection, repair or recalibration — ***without removing dial.***

WRITE FOR THE NEW ACRAGAGE CATALOG, "C-50"

EASIEST TO MAINTAIN

CLAPP INSTRUMENT CO., Webster, Mass.

AIRCRAFT ANTENNA DEVELOPMENT SUPERVISOR

To assume the responsibilities for the development, design and evaluation of airborne antenna for military aircraft. Full knowledge of measurement techniques and 8 to 10 years of related experience required. Also several openings for junior engineers in this field.

Write qualifications to

Employment Office

Chance Vought Aircraft

Box 5907, Dallas, Texas

chart for all models.—The Superior Electric Co., Bristol, Conn.

S-581 "THAT MEN MAY WORK IN SAFETY." 32-page brochure commemorates dedication of "John T. Ryan Memorial Laboratory." Brochure includes short biography of co-founder John T. Ryan plus scenes and commentary on the new laboratory and maker's products.—Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh 8, Penna.

S-582 RECEIVING TUBES. 24-page catalog gives characteristics and socket connections for more than 450 of maker's receiving and picture tubes for AM, FM and TV broadcast; also has chart classifying tubes as to family, function, filament or heater voltages. Price 10 cents.—Commercial Engineering, Tube Dep't, Radio Corp. of America, Harrison, N. J.

S-583 "USES UNLIMITED." 2-page Vol. 6, No. 2 issue of this house organ features article on maker's switch units in high-speed container handling; also describes and pictures several additions to maker's line of switches and actuators.—Micro Switch, Freeport, Ill.

S-584 RECORDING VISCOMETER. 8-page Bulletin V-1000B illustrates and describes maker's recording viscometer for manual or automatic 24-hour viscosity control; covers outstanding features, design and operations, typical applications, and specifications.—Norcross Corp., 247 Newtonville Ave., Newton 58, Mass.

S-585 VALVES. 48-page Catalog No. 52 describes maker's line of stainless steel valves, fittings and accessories including engineering drawings, weights, dimensions, size ranges, materials, corrosion data and design information.—Cooper Alloy Foundry Co., Hillside, N. J.

S-586 "CHROMALOX NEWS." 4-page issue No. 41 of this house organ covers application to industry of maker's line of electrical heating units and equipment.—Edwin L. Weigand Co., 7500 Thomas Blvd., Pittsburgh 8, Penna.

S-587 METAL MACHINING. 12-page Bulletin No. 41 gives recommended practices for machining, grinding, honing, polishing etc. of maker's line of metals; also covers tool design and inspection.—Ampco Metal Inc., 1745 S. 38th St., Milwaukee 46, Wis.

S-588 TRANSFORMERS. 16-page Bulletin P550 describes line of variable transformers and line correctors. Includes data on "Voltbox" a-c. power supplies and "Powerstats," photographs, performance curves, graphs and wiring diagrams.—Superior Electric Co., Bristol, Conn.

S-589 WATER HARDNESS TESTS. 4-page Bulletin 1RE-50 describes new "one-minute tests" for determining water hardness. Procedures, reagents and equipment used are pictured and described.—Hall Laboratories, Inc., Hagan Bldg., Pittsburgh 30, Penna.

S-590 VIBRATION CONTROL. 12-page illustrated booklet describes development, application and engineering service of maker's line of mounts for vibration and shock control. Diagrams included.—The Barry Corp., 179 Sidney St., Cambridge 39, Mass.

S-591 RECORDING EQUIPMENT. 4-page Folder N-91(1a) illustrates and describes maker's sulfur dioxide recording and control equipment; gives various operating and design features.—Leeds and Northrup Co., 4934 Stenton Ave., Philadelphia 44, Penna.

S-592 TOOLMAKERS MICROSCOPE. 8-page Bulletin 147-50 describes and illustrates maker's two new models of microscopes. Specifications, features and accessories listed.—Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

S-593 RADIATION-DETECTION DENSITOMETER. 3-page Bulletin 490 describes maker's "Model 400R radiation-detection densitometer for measurement of the optical density of dental size x-ray film.—Photovolt Corp., 95 Madison Ave., New York 16, N. Y.

S-594 PHOTOELECTRIC AMPLIFIERS. 8-page catalog covers maker's line of photoelectric amplifiers for counting, production line control, inspection, smoke control and other industrial applications. Illustrated.—De-Tec-Tronic Labs, Inc., 1227 North Clark St., Chicago 10, Ill.

S-595 ROUGHNESS TESTING. 4-page illustrated Bulletin L-13 discusses and compares surface roughness rating by "feel" and visual comparison.—Physicists Research Co., 32 South Main St., Ann Arbor, Mich.

S-596 THERMAL SWITCH. 2-page Data Sheet 56 describes and illustrates maker's "Temp-Cop" snap-action thermal switch. Includes rating, calibration and other data, features, and price listings.—Micro Switch, Freeport, Ill.

S-597 "THE C-D CAPACITOR." 16-page Vol. 15, No. 8 issue of this house organ includes articles on dual-range impedance meter and radio trading post listings.—Cornell Dubilier Electric Corp., Hamilton Blvd., South Plainfield, N. J.

S-598 "PRECISIONOMICS." 4-page Vol. 2, No. 3 issue of this house organ includes articles on protection of American instrument industry, World Trade Fair and maker's products.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

S-599 "MODERN PRECISION." 8-page Vol. 10, No. 2 issue of this house organ includes articles on maker's "Micromax" and "Speedomax" recorders as well as on helicopter tests and "True Temper" golf club shafts.—Leeds & Northrup Co., 4902 Stenton Ave., Philadelphia 44, Penna.

S-600 ALUMINUM TUBING. 6-page booklet describes and illustrates maker's line of aluminum tubing for instrument use. Includes data tables and applications.—Aluminum Company of America, Pittsburgh 19, Penna.

S-601 TEST INSTRUMENTS. 8-page Bulletin 19-50 covers maker's line of instruments and laboratory equipment for electrical and scientific testing. Includes a brief description of maker's complete line.—James G. Biddle Co., 1316 Arch St., Philadelphia 7, Penna.

S-602 MICROMANOMETER. Single sheet illustrates and describes maker's "Model 179-A" micromanometer; covers principle of operation, specifications.—Clarke Instrument Corp., Silver Spring, Md.

S-603 "TAYLOR TECHNOLOGY." 28-page Vol. 3, No. 1 issue of this house organ features articles on instrumentation in modern breweries, food processing and candy industries. Includes second installment on "Shop Facilities for Testing Temperature Instruments."—Taylor Instrument Companies, Rochester 1, N. Y.

S-604 PNEUMATIC TRANSMITTERS. 4-page bulletin illustrates and describes maker's "F-C Series 5000" pneumatic transmitters; includes theory of operation, specifications and applications.—Instruments Inc., Tulsa, Okla.

S-605 BRIDGE AMPLIFIER. 4-page bulletin covers installation, operation, features and diagrams for maker's "Model 850-B" bridge amplifier.—Brown Electro-Measurement Corp., 4635-37 S.E. Hawthorne Blvd., Portland 15, Ore.

S-606 IMPEDANCE BRIDGE. 4-page illustrated bulletin describes maker's "Model 250-B" universal impedance bridge; includes diagrams, applications, features, specifications.—Brown Electro-Measurement Corp., 4635-37 S.E. Hawthorne Blvd., Portland 15, Ore.

S-607 TIMER. 4-page Bulletin 2000C describes maker's "Type DU" duplex cycle timer; lists function, application, features, construction, etc.—R. W. Cramer, Inc., Centerbrook, Conn.

S-608 BAROMETER. 2-page Publication No. TP-35-A covers design, operation, construction and specifications for maker's "FA-160181" laboratory type aneriod barometer.—Wallace and Tiernan Products, Inc., Belleville 9, N. J.

S-609 OIL TESTER. 4-page Bulletin No. 750 describes and illustrates maker's "Model 75" photoelectric crankcase oil tester; covers working principle, operation.—Photovolt Corp., 95 Madison Ave., New York 16, N. Y.

S-610 COLORIMETER. 4-page Bulletin 409 pictures and describes maker's "Model 401" photoelectric colorimeter; gives applications, operation and features as well as price listings.—Photovolt Corp., 95 Madison Ave., New York 16, N. Y.

S-611 LABORATORY WATER BATH. 2-page bulletin illustrates and describes maker's water bath and mechanical tube holder for

UNIVERSITY OF MICHIGAN LIBRARIES